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FINAL REPORT

WETLAND STATUS SUMMARY

AMRB Task Order 93-007-05

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EXECUTIVE SUMMARY

The performance of three wetland treatment systems for acid mine drainage was evaluated. The wetlands were constructed between 1990 and 1992 by the Montana Department of State Lands Abandoned Mine Reclamation Bureau (AMRB). They include a constructed wetland at French Coulee near Belt, Montana with approximately 1.3 acres of treatment area, a constructed wetland with anoxic limestone drain (ALD) pretreatment at Centerville, Montana with 1.0 acres of effective treatment area and a linear wetland with ALD pretreatment at Stockett, Montana with less than 0.1 acre of effective treatment area. The operating experience with these wetlands shows that none of them function as "passive" treatment systems. None of the systems provide sufficient treatment for reduction of acidity and precipitation of dissolved metals to comply with even the least restrictive water quality standards such as livestock water.

Physical flow control problems have been major concerns at all three sites. These problems are summarized as follows:

- **Fouling of buried pipe systems.** Fouling of buried piping with inorganic precipitates and bacterial slime is a chronic problem at French Coulee and has occurred at the other two sites as well during their short operating history. Piping at the French Coulee site has been successfully cleaned using sewer cleaning equipment. However, the long term effectiveness of this procedure is uncertain. Operating experience suggests that fouling is liable to reoccur quite quickly.

- **Winter freezing.** The development of thick ice sheets on pond surfaces during the winter leads to uncontrolled flow patterns resulting in loss of containment and limited opportunity for proper contact with substrate.

- **ALD plugging.** Anoxic limestone drains quickly became plugged by precipitates from the mine water treated at the sites using this technology. The water contains elevated concentrations of metals such as ferric iron, aluminum and sulfate that are too high for effective treatment in an ALD.

In addition to these physical problems, chemical treatment capacity has been much less than anticipated. At Centerville and Stockett, the failure of the ALDs because of plugging has been a significant factor in loss of chemical treatment. Centerville continues to provide a significant level of acidity and metal reduction because of the high limestone content of the wetland substrate. However, because operation has been reduced to contact by surface flow due to the failure of the buried distribution system, the available supply of limestone is limited and the readily available lime at the surface is expected to be depleted soon. There are indications this has already occurred in the first of the three treatment cells at Centerville.

At French Coulee, where chemical treatment is afforded only by contact with the organic substrate and there was no limestone additive to the substrate, the reduction of total acidity and metals in effluent water is currently only about one-fourth of what is required to maintain near neutral pH levels. Data indicate that at least half of the reduction in acidity which occurs can be attributed to inherent natural alkalinity which

is still present in the substrate after two years of operation. As this alkalinity is exhausted, further deterioration in performance is anticipated. The mechanism or mechanisms responsible for the remainder of acidity reduction are not clearly established from the available data although biological sulfate reduction is the probable process involved. Other possibilities include precipitation of aluminum and iron hydroxy-sulfates and gypsum. There is some indication from the data that the contributions of these mechanisms toward acidity reduction are declining and may be influenced by the loss of natural alkalinity in the substrate.

Wetlands were hoped to provide a low maintenance alternative for treatment of acid mine drainage. Based on the experience of the Montana AMRB, in severe winter climates and with water containing high acidity and high concentrations of dissolved metals, this is not the case.

1.0 BACKGROUND

Acid mine drainage (AMD) is present at many abandoned coal and hardrock mines and results when pyrite-rich coal, ore or associated overburden is exposed to oxidizing (weathering) conditions. The result is an acidic effluent characterized by low pH (2 to 4) and/or elevated levels of TDS, sulfate, aluminum, iron, manganese and possibly other trace metals (British Columbia ARD Task Force 1989). In the past few years, the use of constructed wetlands as a passive means of treating AMD has received considerable attention (Girts and Kleinmann 1986; Girts, 1987; Hedin, 1988; Wieder, 1990; Taddeo and Wieder, 1991; Calabrese, 1991 and others). Much of this work was done on AMD from eastern coal mines which is typically characterized by relatively low acidity, TDS and metal concentrations because of the high infiltration rates compared to conditions found at western mine sites. The appeal of constructed wetlands is their reported potential to treat AMD with minimal operating and maintenance costs.

Most constructed wetlands have been designed as crossflow systems, where AMD flows over a substrate and metals are removed primarily via oxidation and the formation of metal hydroxyoxides. Often there is very little increase in pH. However, it has recently been recognized that some metals can also be removed by producing and maintaining reducing conditions sufficient to precipitate metal sulfides (McIntire, 1990; Taddeo and Wieder, 1991; Dvorak, 1991). It is the decaying organic materials (substrate) in wetlands that provides the chemical driving force for such reducing conditions. Wetlands designed to maximize contact of the AMD with the substrate to optimize microbial sulfate reduction have been observed to produce a significant increase in pH in addition to metal removal. To optimize sulfate reduction, a substrate must provide a readily-metabolized source of organic carbon and adequate nitrogen for the sulfate reducing bacteria. Additionally, the substrate should support the growth of cattails or other aquatic plants which, through photosynthesis, will become a long-term source of organic carbon and a source of nutrients for the bacteria. Uniform physical structure and moderate to rapid hydraulic conductivity (10^{-4} to 10^{-3} cm/s) are also a necessary attribute in order to prevent short-circuiting and to allow for maximum contact with the substrate.

The Montana Department of State Lands, Abandoned Mine Reclamation Bureau (AMRB) has constructed three wetland systems in Cascade County for treatment of acid mine drainage to assess the applicability of wetland treatment systems on AMD from underground coal mines. The wetlands are located at French Coulee near Belt, Montana, at the Cottonwood "C" seep near Centerville, and at the Stockett SE site. None of the wetlands has consistently provided satisfactory removal of acidity and metals without the need for frequent and extensive maintenance.

AMRB has accumulated performance data on these three wetlands and has authorized the preparation of this report to evaluate this data and the operational history to determine the status of its wetlands as treatment systems for coal acid mine drainage.

2.0 FRENCH COULEE WETLAND

2.1 Operational History

The French Coulee wetland construction began in the fall of 1990 and was completed in the spring of 1991. The wetland was designed as an experimental testbed for biological treatment of acid mine drainage (AMD). Schafer and Associates was Engineer and Construction Inspector for the project and Ed Boland Construction, Inc. of Great Falls was Contractor.

A plan drawing of the French Coulee Wetland is provided in Figure 2.1. This wetland, consisting of three cells in series with approximately 1.3 acres of effective treatment area typically receives 15 to 25 gpm of AMD. It was designed with the capability to treat AMD either in upflow mode (AMD is introduced into a gravel sublayer and flows upward through the organic substrate), in downflow mode (AMD is applied to the surface and percolates through the organic substrate to collection piping in the gravel) or in crossflow mode (AMD flows across the wetland surface with minimal contact with organic substrate). The substrate used at French Coulee consisted of composted wood waste / municipal sewage sludge and one layer of aged cow manure just above the gravel layer. Treatment of AMD began on July 2, 1991 with all cells in upflow mode. The practical advantage of this flow mode is to minimize contact of the AMD with oxygen from the atmosphere thereby maintaining reducing conditions as much as possible.

The wetland initially provided a high level of removal of iron, aluminum and other metals and produced a neutral effluent from influent AMD with unusually high metal loading and acidity. However, on site visits August 22, 1991 and October 17, 1991 there were indications of AMD breakthrough from the final treatment cell. This appeared to be an intermittent problem caused by screen clogging at the inlet to distribution piping. It was shown that this condition could be rectified. The wetland worked well between October 17 and November 13 and screen clogging seemed to be less compared to earlier site inspections immediately after start-up. However, this problem is a recurring one requiring screen cleaning every few weeks.

On January 21, 1992, severe short-circuiting of the wetland was observed and iron staining was noted in a small stream downstream of the wetland which runs about one quarter mile to Belt Creek. The short-circuiting of the wetland was apparently brought on by ice formation which interfered with the proper flow of water through the organic substrate materials. A decision was made to shut the wetland down at least for the winter and evaluate possible remedies. At this time AMD was diverted back to the original pipeline and culvert that delivered the AMD to a collection ditch on the north side of the Burlington Northern tracks and eventually into Belt Creek. Analyses of the small stream indicated a neutral pH and no significant effect on water quality. No downstream effects on Belt Creek were observed.

An interim operational report was prepared during this period (Schafer and Associates, 1992). The report concluded that system short-circuiting from clogging screens and pipelines and ice formation were responsible for the breakthrough of AMD.

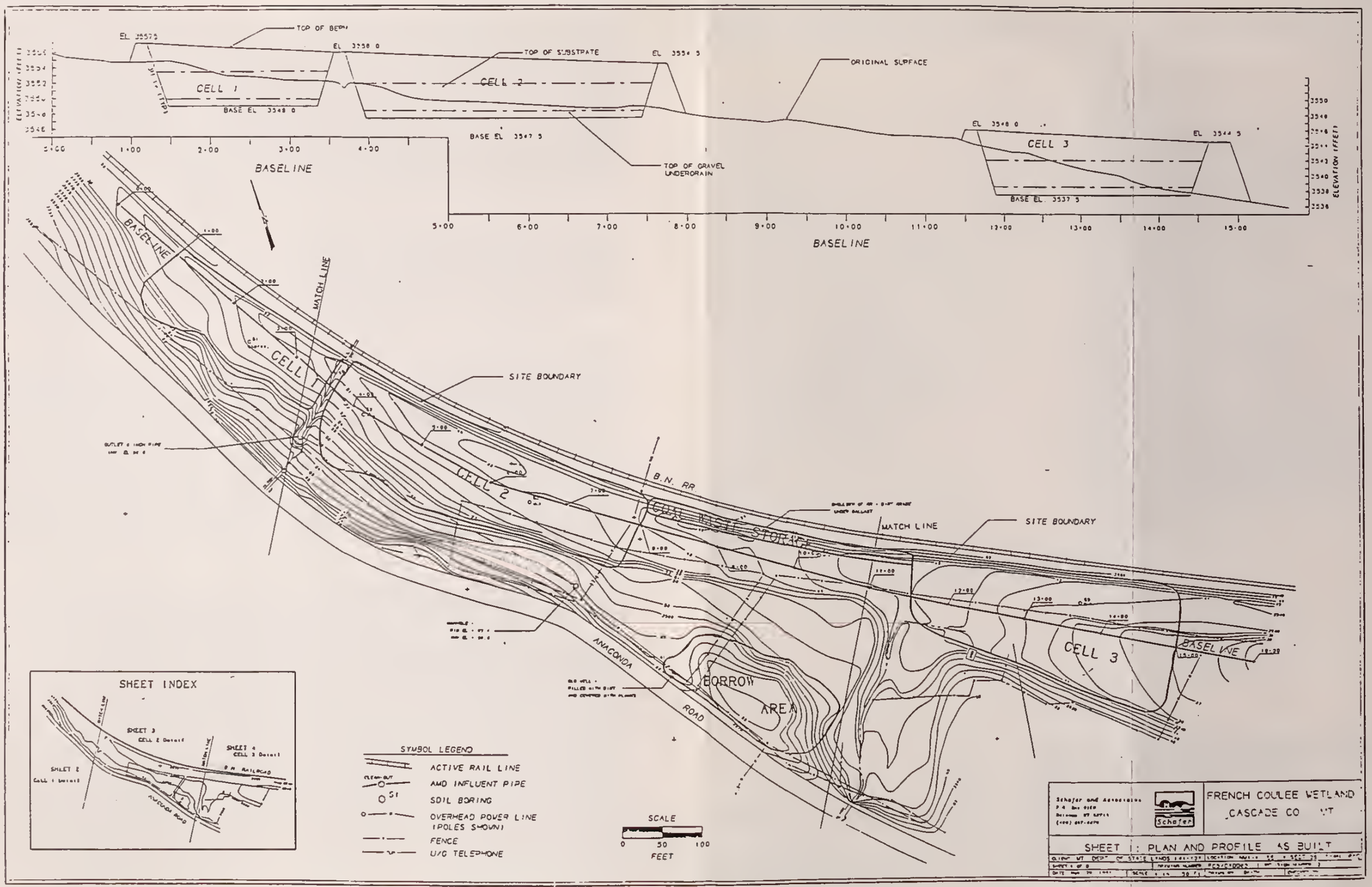


Figure 2.1 French Coulee Wetland plan.

The report also found that inherent neutralization capacity or ion exchange capacity was responsible for much of the observed metal removal and acid neutralization. There was some evidence of active sulfate reduction in the form of hydrogen sulfide odor in effluents and black precipitates in flumes, especially in the effluent flume from Cell 3. However, the amount of sulfate reduction being achieved was judged to be insufficient to maintain effective treatment over the long term. Roughly half of the sulfate entering the wetland was still being discharged as $CaSO_4$ and $MgSO_4$ derived from cations in the substrate and there was a possibility that additional sulfate was precipitating in the substrate in the form of gypsum ($ASO_4 \cdot 2H_2O$), jarosite ($KFe_3 (SO_4)_2(OH_6)$) or alunite ($KAl_3 (SO_4)_2(OH)_6$). When inherent sources of alkalinity were depleted, breakthrough of metals, present as metal-sulfate ion pairs was expected to occur.

Modifications were made to the wetland in the summer of 1992 to provide a valve in the wetland main pipeline that could be opened or closed as required to facilitate future water diversions if necessary. Flow was reestablished in August, 1992 in downflow mode. It was felt that downflow operation would help to minimize some of the screen plugging problems which were experienced earlier.

Sampling was resumed on September 3, 1992 but was discontinued after November 2, 1992 because of operational problems brought on by winter weather and continued problems with flow control because of pipe and screen clogging. All three cells were set to crossflow operation because it was felt this would provide the best control of AMD flow in icing conditions. However, massive ice sheets formed over the wetlands and at times AMD was not contained within the lined cell areas. This was especially true in the area immediately above Cell 1. AMRB personnel attempted to divert water from the wetland to the old collection ditch using the newly installed valve but found that similar problems with ice sheets were encountered with the collection ditch, this time impacting the road north of the Burlington Northern tracks. AMRB was able to split the flow between the wetland and the ditch and maintain satisfactory flow through the winter months in that mode.

In the spring of 1993, Cells 1 and 2 were reset to downflow mode. Cell 3 was left in crossflow mode apparently with the intention of obtaining metal removal through oxidation of ferrous iron to ferric and precipitation of iron hydroxides. The wetland has operated in this mode since then with sampling performed on a monthly basis through July, 1993. During this period it was determined that partial plugging of the subsurface distribution piping was preventing complete treatment of the AMD. A portion of the flow in both Cells 1 an 2 flowed through the substrate, but even with exit weirs set to maximum height, the available head was not sufficient to produce enough flow through the media. Consequently, a portion of the flow in both cells was treated in crossflow mode without intimate contact with the substrate. The wetland was designed for cleaning of the distribution piping and the need for periodic cleaning was anticipated. However, no cleaning had been done to date. A sewer cleaning service was hired to do this on October 6, 1993. Cleaning did provide improved flow characteristics. Results of the cleaning are discussed in Section 2.2.1 below. A follow-up sampling was made on October 22, 1993 to assess the impact of the distribution pipe cleaning on wetland treatment performance.

2.2 Observations on Recent Site Visits

2.2.1 Cleaning of Distribution Piping

On October 6, 1993 a sewer cleaning service was hired to clean out the main pipeline and buried distribution piping in the wetland cells. A 1000 gallon vacuum truck was used for this. At the time of cleaning, Cells 1 and 2 were operating in downflow mode and Cell 3 was in crossflow mode with the outlet flume distribution piping blocked off by the weir plate installed for this purpose.

Bacterial fouling was found in the 8 inch main. The vacuum truck was apparently successful in removing this plug. However, the system is equipped with a buried valve at the low point of the 8 inch main located near the outlet weir from Cell 2. Effective cleaning can be done simply by opening this valve and draining the main into Cell 3. The standing head in the main produces a rapid high volume discharge through the entire 8 inch piping system. This was done in addition to vacuum truck cleaning and seemed to dislodge additional material from the piping.

The perforated piping buried in the gravel bed was also found to be partially plugged. Both Cell 1 and Cell 2 were not able to accommodate the entire wetland flow in downflow mode. With weirs set for maximum standing water in the wetland, there was still a substantial portion of total flow over the weir (crossflow) instead of through the substrate (downflow). Both Cell 1 and Cell 2 were producing discharge from the buried drainage pipe but this was estimated to be well under 50 percent of the total flow.

The vacuum truck was a very effective tool for cleaning the distribution piping. There was sufficient pumping capacity to completely drain the distribution piping in Cell 1. In Cell 2, recharge rates were too high to completely pump down the piping. This is probably due to the much greater surface area of Cell 2 and longer installed length of perforated pipe. After cleaning of Cell 2, discharge from the underdrain was so high that the Parshall flume in Cell 3 was flooded and a flow measurement was not possible. Only two of the nine distribution pipes in Cell 3 were cleaned because of diminishing daylight. AMRB personnel preferred to leave this cell in crossflow mode during the winter because their experience indicated there would be fewer problems due to ice formation. It is their intention to clean all the distribution piping again in the spring at which time Cell 3 should be returned to either upflow or downflow mode.

Fouling of the perforated piping seemed to consist primarily of sediment. The color of the sediment pumped from the piping became increasingly dark from Cell 1 to Cell 3 which could be an indication of an increasingly reducing environment. A few loosely consolidated gelatinous sediment globules less than half an inch in diameter were also observed. These were readily broken up by agitation. It is not clear whether the gelatinous nature of these globules is due to the presence of bacteria or inorganic precipitates. However, a very dark, thin film of sediment covered the outer surface of the globules while the interior was much lighter in color indicating chemical reaction of some sort at the surface.

2.2.2 Follow-up Site Inspection after Pipe Cleaning

On October 22, 1993 a follow-up inspection was made at the French Coulee Wetland. Cell 1 was performing better but was still incapable of accepting the entire flow in downflow treatment mode. An estimated 40 percent of total flow was in crossflow. Samples of both the underdrain and the overflow were collected to compare relative treatment efficiencies. Samples were also collected from other locations to compare against earlier data before cleaning the discharge piping. Cell 2 was flowing entirely in downflow mode. Cell 2 effluent contained precipitates which gave the water a milky appearance and a white coating was present in the 12 inch collection header at the discharge of Cell 2. Subsequent water analysis suggests that this is probably an aluminum precipitate. The pond water elevation had dropped nearly 6 inches and appeared to be in an equilibrium condition judging from flume measurements into Cells 2 and 3. The cleaning was clearly beneficial from a flow control standpoint.

2.3 Water Quality Data Review

The Interim Operational Report (Schafer and Associates, 1992) provides an interpretation of data collected during the first six months of operation. Additional data has been collected by AMRB since operation was resumed in the summer of 1992. This data is tabulated in Appendix A. Analytical reports are provided in Appendix A as well. Section 2.3.1 below is a summary of observations made with particular attention to the data collected since September, 1992. Section 2.3.2 looks at the changes in acidity that have occurred in individual cells over the entire operating history in order to gain insight into the chemical mechanisms for reduction of acidity in this wetland.

2.3.1 Analysis of Data Collected Since September, 1992

The following observations are made regarding the most recent data collected at French Coulee:

- The wetland continues to provide alkalinity as determined from increased calcium and magnesium analysis in the treated water as shown in Figures 2.2 and 2.3. However, the contribution from Cell 1 seems to be essentially depleted. Cell 2 still provides calcium and magnesium but this supply is probably being slowly depleted. Since Cell 3 has been operated in crossflow mode any remaining alkalinity in the substrate has probably not been readily available. The effects of distribution pipe cleaning can be seen in calcium and magnesium analyses on 10/22/93. However, a similar response was observed on 6/7/93 without apparent cause. It is possible that this sample was taken during a period of high evaporation loss which may have produced a concentrative effect, but no similar responses are seen for other components like TDS and Fe. Another, more probable explanation, is that high evaporative losses reduced discharge rates from Cell 2 sufficiently that the entire flow could be accommodated by downflow percolation producing better overall treatment and the higher calcium and magnesium analyses which were observed. This could easily be the case if samples were taken toward the end of a sunny day in which the surface water had warmed considerably. Unfortunately, flow rates were measured only at the inlet

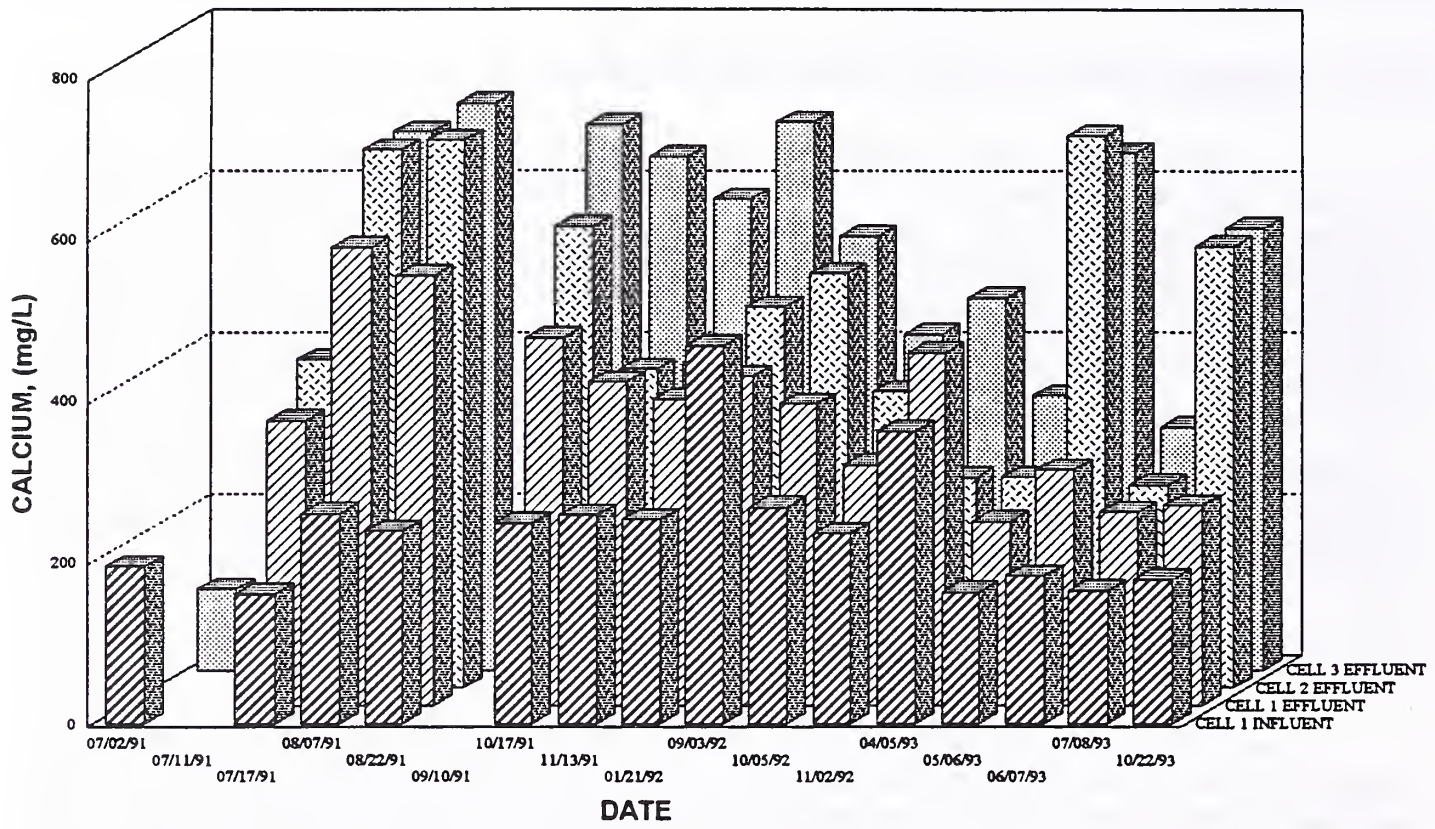


Figure 2.2. Concentration of calcium in waters at the French Coulee wetland since start-up.

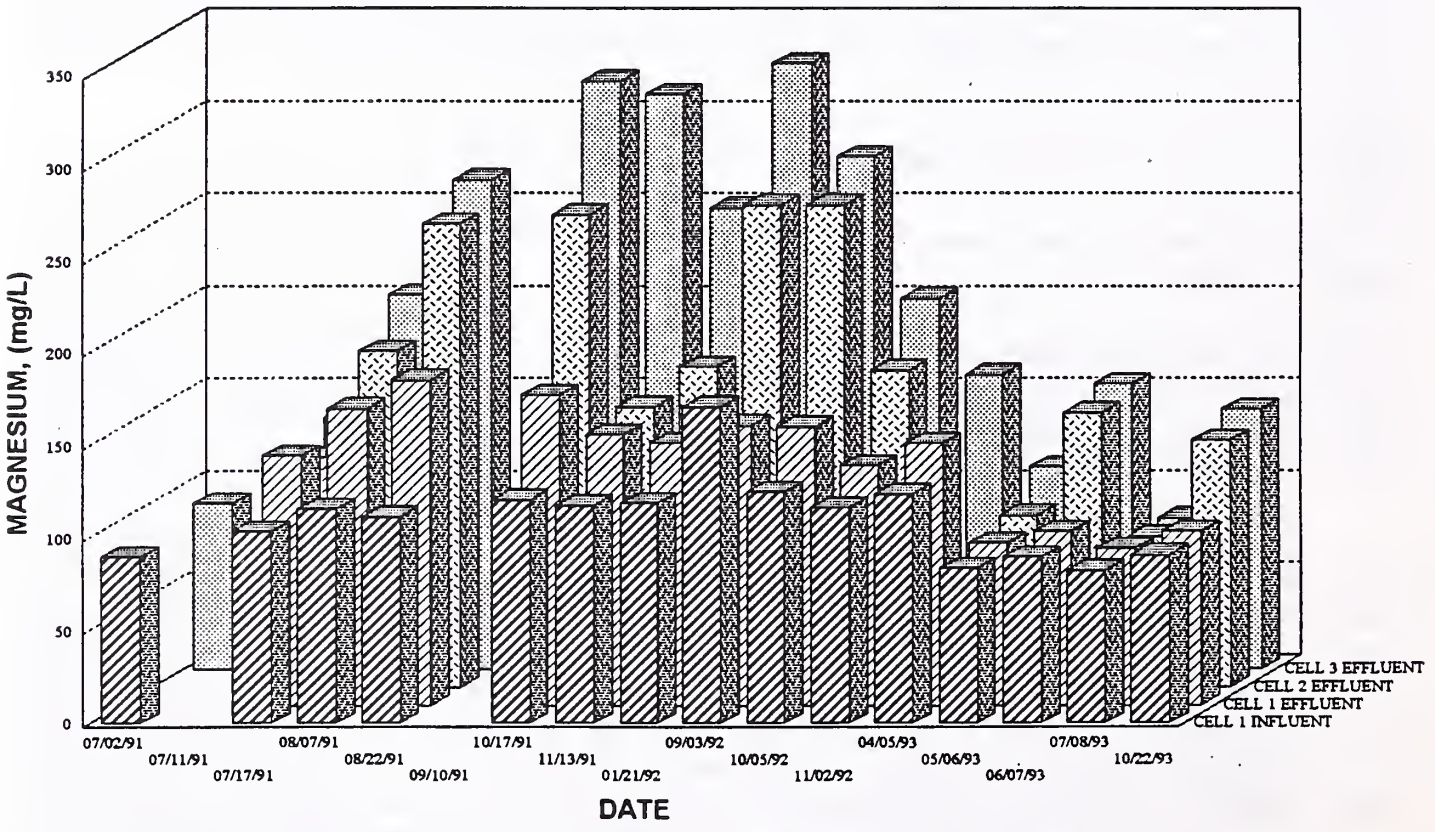


Figure 2.3. Concentration of magnesium in waters at the French Coulee wetland since start-up.

to Cell 1. Consequently, no data is available regarding intercell flows, which would provide an indication of evaporative losses.

- The ferrous iron content of treated water (Figure 2.4) was high during the first few months of operation. However, over the last year it has been difficult to maintain these highly reducing conditions. This is probably due to the inability to maintain contact with the substrate because of plugging in the distribution piping resulting in a higher percentage of total flow as crossflow. Readily available sources of organic carbon may also be depleted. There have been occasions when reducing conditions were improved. Those times when it appears that Cell 2 was providing effective treatment based on lower acidity and metal concentrations (6/7/93 and 10/22/93), exhibited a more reducing environment. However, the most highly reducing conditions were on 4/5/93 after all cells had been in crossflow mode for the winter and flow was split between the wetland and the old AMD collection ditch. These reducing conditions might have been caused by winter ice buildup Similar conditions in lakes sometimes result in fish kills attributable to lack of oxygen if organic matter is high and the ice is thick enough. Another possibility is that better reducing conditions may have resulted from the reduced flows through the wetland and increased residence time. Finally, a third possibility is that these analyses may reflect a return to operation in downflow mode in which case the first water collected may have been sitting stagnant for several months. Field notes are not clear when flow modes were changed and whether sampling occurred before or after changing flow modes.

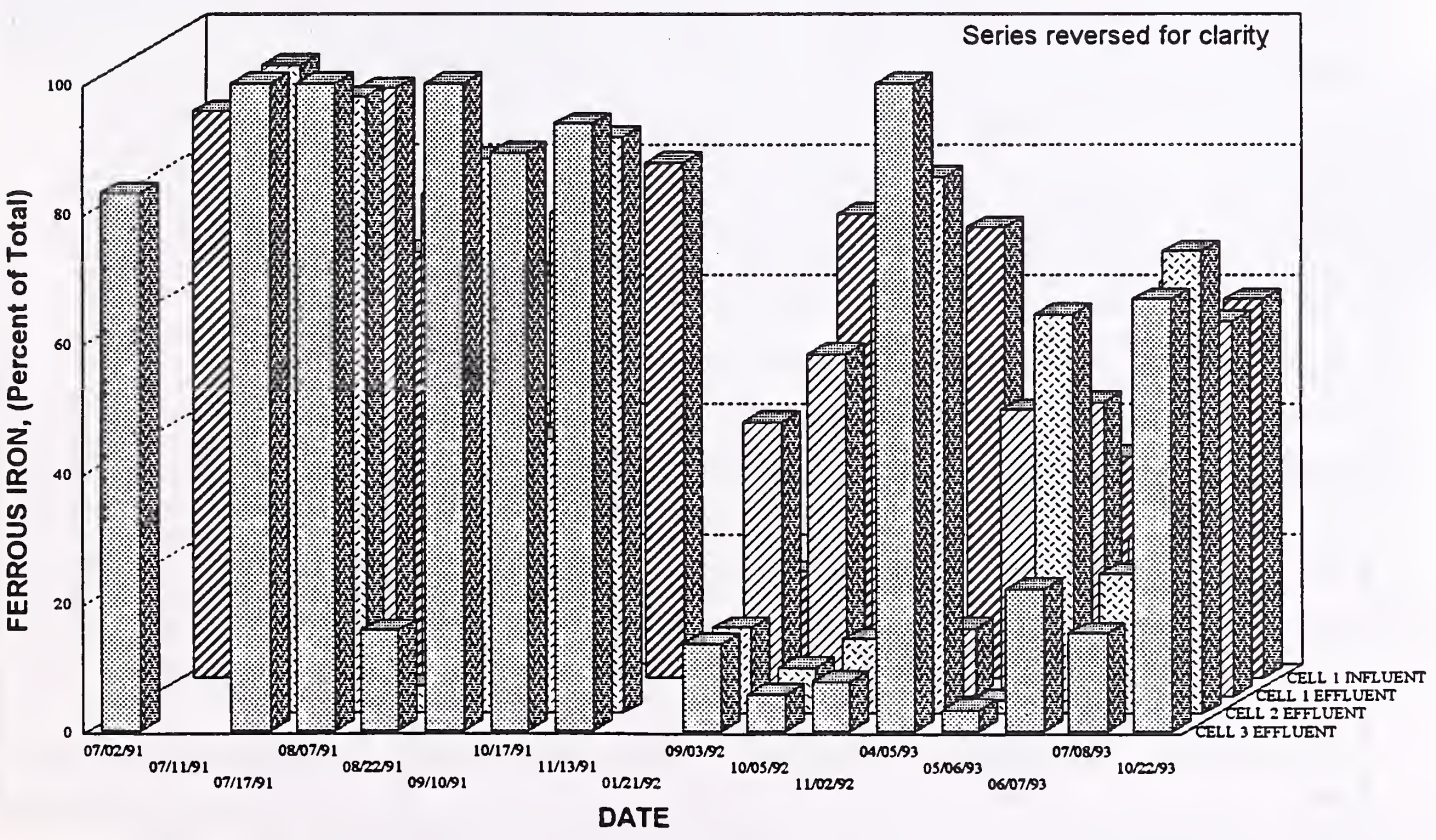


Figure 2.4. Chemical reduction of iron at French Coulee. Difficulty maintaining reducing conditions is reflected in lower ferrous iron percentages.

- The effects of a relatively wet year during 1993, especially during the summer, is reflected in the lower analyses for most major constituents. However, measured AMD flow rates do not appear to have increased proportionately to the dilution observed. Earlier periods of unmeasured high flow may have purged water containing high TDS from underground reservoirs.

- The samples on 4/5/93 also appear to be diluted in Cell 2 based on the low Ca and Mg analyses in the effluent from Cell 2. These analyses are only 50 to 70 percent of the influent AMD in Cell 1. This is probably the result of melting snow and ice which accumulated during the winter.

- The data from the last sampling taken after the distribution piping was cleaned are revealing. Table 2.1 summarizes these results. The wetland had been operating for over two weeks since the pipes were cleaned and it is believed that the data is a good representation of current wetland performance characteristics in a steady state condition. Cell 1 was estimated to be flowing 60 percent downflow and 40 percent crossflow. This ratio is confirmed by Ca, Fe^{+2} and Fe^{+3} analyses in the distribution pipe header (downflow effluent), the overflow of the outlet flume (crossflow effluent) and a combined flow sample.

Table 2.1. Operational parameters and analytical data for the French Coulee Wetland following distribution pipe cleaning.

Component		Cell 1 Influent	Cell 1 Downflow Effluent	Cell 1 Crossflow Effluent	Cell 1 Combined Effluent	Cell 2 Effluent	Cell 3 Effluent
Flow	(gpm)	23.5	NM	NM	22.3	18.8	NM
pH	(su)	2.4	2.9	2.6	2.6	4.1	2.9
EC	(mmhos/cm)	3.62	3.67	3.32	3.55	3.78	3.75
TDS	(mg/l)	5320	5740	4960	5600	5380	5070
Acidity	(mg/l as $CaCO_3$)	3180	3000	3090	3680	1930	1840
SO_4^{-2}	(mg/l)	3680	3860	3610	3700	3640	3530
Fe (total)	(mg/l)	555.0	479.0	534.0	467.0	413.0	354.0
Fe^{+2}	(mg/l)	324.0	383.0	148.0	270.0	295.0	236.0
Fe^{+3}	(mg/l)	231.0	96.0	386.0	197.0	118.0	118.0
Al	(mg/l)	290.0	NA	NA	309.0	185.0	173.0
Zn	(mg/l)	4.91	NA	NA	4.63	0.98	1.48
Ca	(mg/l)	178	293	192	247	547	547
Mg	(mg/l)	91	98	97	94	134	141

NM = No Measurement
NA = Not Analyzed

and Fe^{+3} analyses in the distribution pipe header (downflow effluent), the overflow of the outlet flume (crossflow effluent) and a combined flow sample.

- Data indicate that although iron is chemically reduced in downflow mode it is not effectively immobilized. Generation of S^{-2} must not be sufficient to produce significant levels of iron sulfide precipitation. Additional iron removal was obtained in Cell 3 but this appears to be the result of hydrolysis since the pH dropped back down to 2.9 while total acidity actually declined somewhat.

- Similarly, aluminum is not being completely immobilized, although on 6/7/93 nearly complete aluminum precipitation was obtained with most of that occurring in Cell 2.

- Acidity was reduced substantially (from 3020 ppm to 1930 ppm) in Cell 2 after distribution pipe cleaning. However, as Table 2.2 shows for Cell 2 on 10/22/93, much of the reduction in acidity is potentially attributable to Ca and Mg derived from substrate sources. This could be either from inherent neutralization capacity (carbonates, oxides or hydroxides) or ion exchange capacity. Similar data for Cell 1 on the same date indicate very little reduction in acidity with much of that potentially accounted for by increases in Ca and Mg. Table 2.2 is shown with both raw analytical data and with flow normalized data to account for flow differences in and out of the cells which indicates net evapotranspiration and precipitation effects.

Table 2.2 An analysis of acidity reduction in individual cells following distribution pipe cleaning.

	Raw Data Cell 1 10/22/93 (mg/l $CaCO_3$)	Flow Normalized Data Cell 1 10/22/93 (mg/l $CaCO_3$)	Raw Data Cell 2 10/22/93 (mg/l $CaCO_3$)	Flow Normalized Data Cell 2 10/22/93 (mg/l $CaCO_3$)
Acidity In	3,180	3,180	3,020	3,020
Acidity Out	3,020	2,865	1,930	1,627
Net Acidity Change	160	315	1,090	1,393
Potential Alkalinity from Ca and Mg Increase*	188	178	919	775
Unaccounted Acidity Change	(28)	137	171	618

* Assumes all Ca and Mg derived from alkaline sources (oxides, hydroxides, or carbonates)

2.3.2 An In-Depth Look at Patterns of Acidity Reduction In Cells 1 and 2

The analysis of acidity changes in Cells 1 and 2 was made for previous sampling dates going back to the beginning of operation. This data is shown in Figures 2.5 and

2.6. Data was not included for periods of start-up and weir adjustment (7/2/91, 7/11/91, 7/17/91, 9/3/92 and 4/5/93), periods of known or probable ice formation and melting (1/21/92 and 4/5/93), one date for which complete analytical data is not available (9/10/91) and one date (8/7/91) for which data was suspect (Cell 1 influent acidity appears to be too high relative to the SO_4^{-2} reported). Also, there is no flow normalization in this data. Intercell flow measurements are not generally available for making this calculation. Because most usable data is from the summer months when solar radiation is high or during the fall when pond water and substrate may still be warm and the air cool, net water loss is probable across the cells for most data points. The effect of net water loss is to move data points down and to the left on the graphs. This adjustment can be substantial as shown in Table 2.2 for the data on 10/22/93. The effect of a 5 percent evaporation loss is plotted in Figure 2.5 for Cell 1 and a 15 percent loss is plotted in Figure 2.6 for Cell 2. These are the approximate water loss rates as measured on 10/22/93 but significant variations from these values could occur on a daily basis.

Figure 2.5, data for Cell 1, shows a good correlation between potential alkalinity from substrate-derived Ca and Mg and the reduction of acidity across the cell. However, the correlation is not 1:1. Only about 50 percent of the observed acidity reduction can be explained by increases in Ca and Mg. This agrees well with the flow normalized calculation in Table 2.2. One of the most significant aspects of the data is the concentration of recent data points around the origin indicating a general loss of performance in Cell 1 with time. Although, Cell 1 is no longer physically treating the entire flow by substrate contact, this factor does not appear to be responsible for the loss of performance because the fraction which does contact substrate intimately is inadequately treated.

Figure 2.6, data for Cell 2, shows the same general trend as data from Cell 1 but data points are more scattered. This is to be expected because of the large size of Cell 2 relative to Cell 1. The effects of net evaporation are greater and lag times between water in and water out are much greater. Consequently, seasonal differences in evaporation rates and changes in influent water composition introduce greater randomness in data plotting. The reduction in acidity potentially attributable to Ca and Mg from substrate sources is about 60 percent of the total based on the slope of the regression fit. Again this value appears to be confirmed by the flow normalized data in Table 2.2. Unlike Cell 1, significant levels of treatment can still be achieved in Cell 2. However, there is great variability in treatment efficiency just within the last year. This is probably related to the inability to keep flow through the substrate instead of across it.

The most recent data points for Cell 2 are all located above the regression line, closer to a 1:1 correlation line suggesting that mechanisms for acidity reduction other than the inherent neutralization capacity may have been more important during the early days of operation. One possible explanation for this is that as inherent alkalinity is lost, sulfate reduction could become impaired. Kuyucak et. al. (1991) found that bacterial sulfate reduction was suppressed by low pH. Also, column investigations of various substrate materials found that those with the highest inherent alkalinity provided the best AMD treatment (Schafer and Associates, 1991). However, this study was not able to attribute specific percentages of total acidity reduction to inherent alkalinity, sulfate

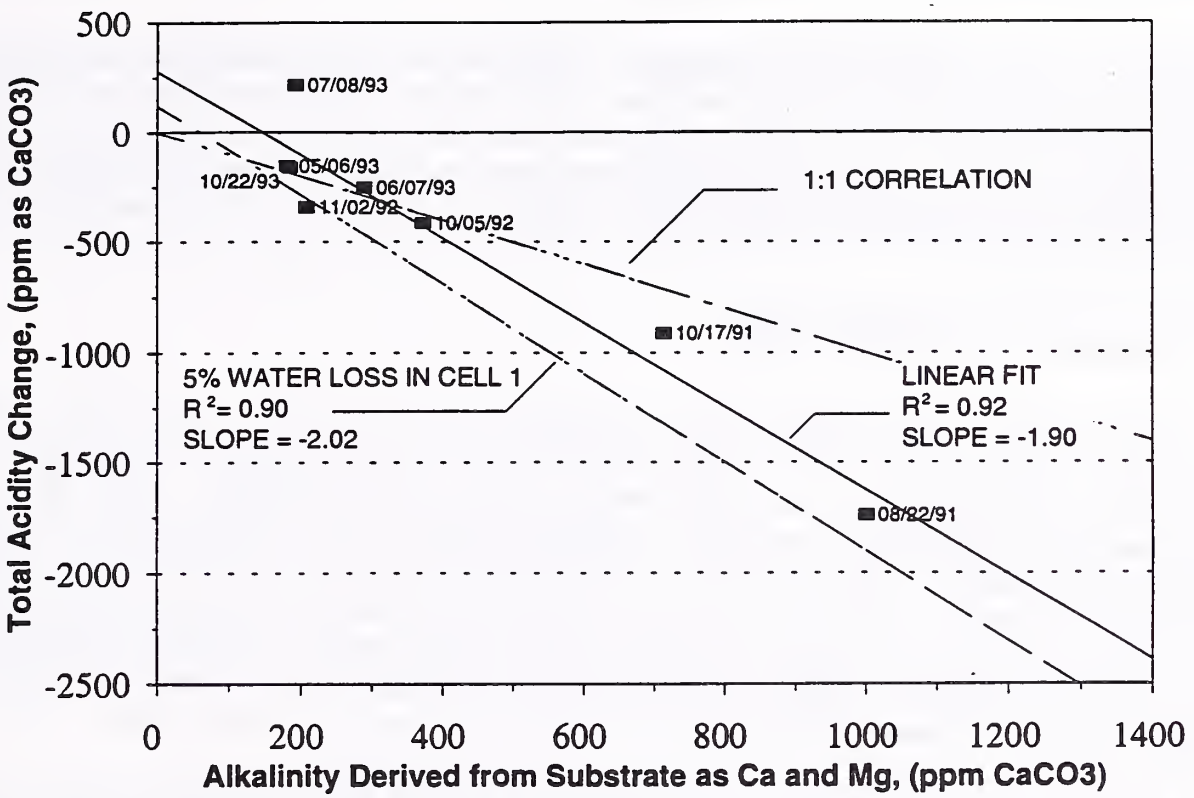


Figure 2.5. Acidity changes in Cell 1. Inherent alkalinity is responsible for much of the acidity reduction. Recent data indicates minimal treatment.

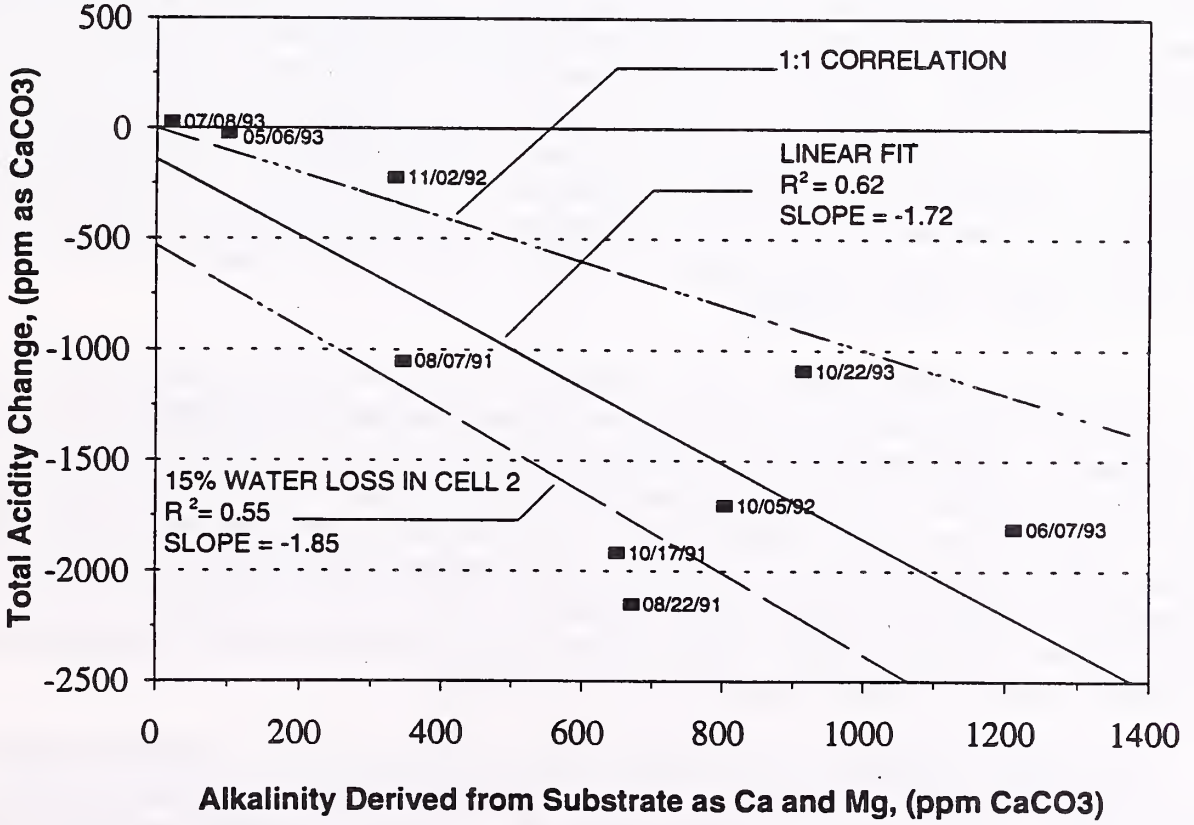


Figure 2.6. Acidity changes in Cell 2. Inherent alkalinity accounts for a higher percentage of acidity reduction. Recent results are variable and more closely related to inherent alkalinity.

reduction, or other possible mechanisms. Impaired sulfate reduction activity could conceivably be manifested on a microscopic scale. Sulfate reducing bacteria in biofilms near a localized source of alkalinity (a grain of limestone, perhaps) might metabolize at a much higher rate than bacteria residing elsewhere. If these localized alkalinity sources are slowly consumed by the acidity in the bulk water, a decrease in sulfate reduction activity could occur.

2.4 Vegetation Assessment

The French Coulee Wetland was seeded in the fall of 1990. A visual observation of the banks, upland slopes and surrounding pasture demonstrated favorable seedling germination, establishment, and plant vigor of all seeded species. A low percent of annual invaders (thistles) were present. Spotted knapweed was also noted in some areas bordering the wetlands. This noxious weed should be controlled before the weeds affect established vegetation. Tordon application will control the knapweed and not damage the grass. Tordon should be applied just before flower bud break, generally in late June or early July. This chemical should not be sprayed near the water. Weeds growing along the water should be hand pulled, plants deposited in bags, and destroyed.

Tall fescue and orchardgrass dominated the wetter sites along the ponds. Smooth brome, western wheatgrass and alsike clover were abundant on the drier, upland areas. A higher density of native forbs were noted on the drier sites including fringed sagebrush, aster and Eriogonum species. This is probably due to less competition from the seeded species. Unfortunately, very few of the trees and shrubs which were planted in the fall of 1991 were present. A few woods rose, snowberry and alder were noted on drier areas at the north end of the corridor between cells 2 and 3. Mortality of the shrubs and trees may be due to a number of factors. The dense cover from the seeded grass species possibly out competed the saplings for moisture and nutrients. It is also possible that deer may have browsed on the young seedlings. Several piles of fresh dirt were noted along cells 1 and 2 indicating rodent activity. Rodents are known to feed on woody species during the winter months.

The cattails were planted in the cells from rhizomes in the spring of 1991. Many of the rhizomes were lost in Cell 1 when the cell was flooded. The cattails in Cell 1 appear to be stressed. A few stands were noted in small patches around the south, east, and north end of the cell. No living vegetation emerged from the center of the pond. The cattails' reproductive seed heads were often undersized and slightly deformed. The cattails in Cell 1 and Cell 2 were notably pale in color. The cattails in Cell 2 were more abundant in number but many were cropped off at about 8 to 12 inches above the water line and brown. The cattails in Cell 3 covered approximately 80% of the water surface and demonstrated a more favorable wetland habitat.

It has been considered that cattails were dying because of excessive water depth or an anoxic root zone. However, conditions of water depth and rooting media are the same in Cell 3 where the cattails are doing well. The most probable reason that cattails are dying in Cells 1 an 2 but not in Cell 3 is metal accumulation. Iron precipitates were noted along the banks of the cell. Generally plants will exhibit tissue burning on the tip if metal uptake is too high and die back slowly. Vegetation monitoring would help

determine which metals are accumulating in the plants and in what concentrations. For example, a literature search indicates iron uptake by cattails is concentrated in the rhizomes whereas manganese accumulates in the plant tops. The shifting of contaminants to senescing leaves at the end of the growing season is a known strategy for plant survival in contaminated locations. Published data suggests that lower pH and higher aluminum concentrations present problems for cattail survival and germination.

3.0 CENTERVILLE "C" WETLAND

3.1 Operational History

Construction of the Centerville "C" wetland began in the fall of 1991 and was completed in the summer of 1992. Robert Peccia and Associates was Engineer and Construction Inspector for the project and Sharbono Construction of Helena was the Contractor.

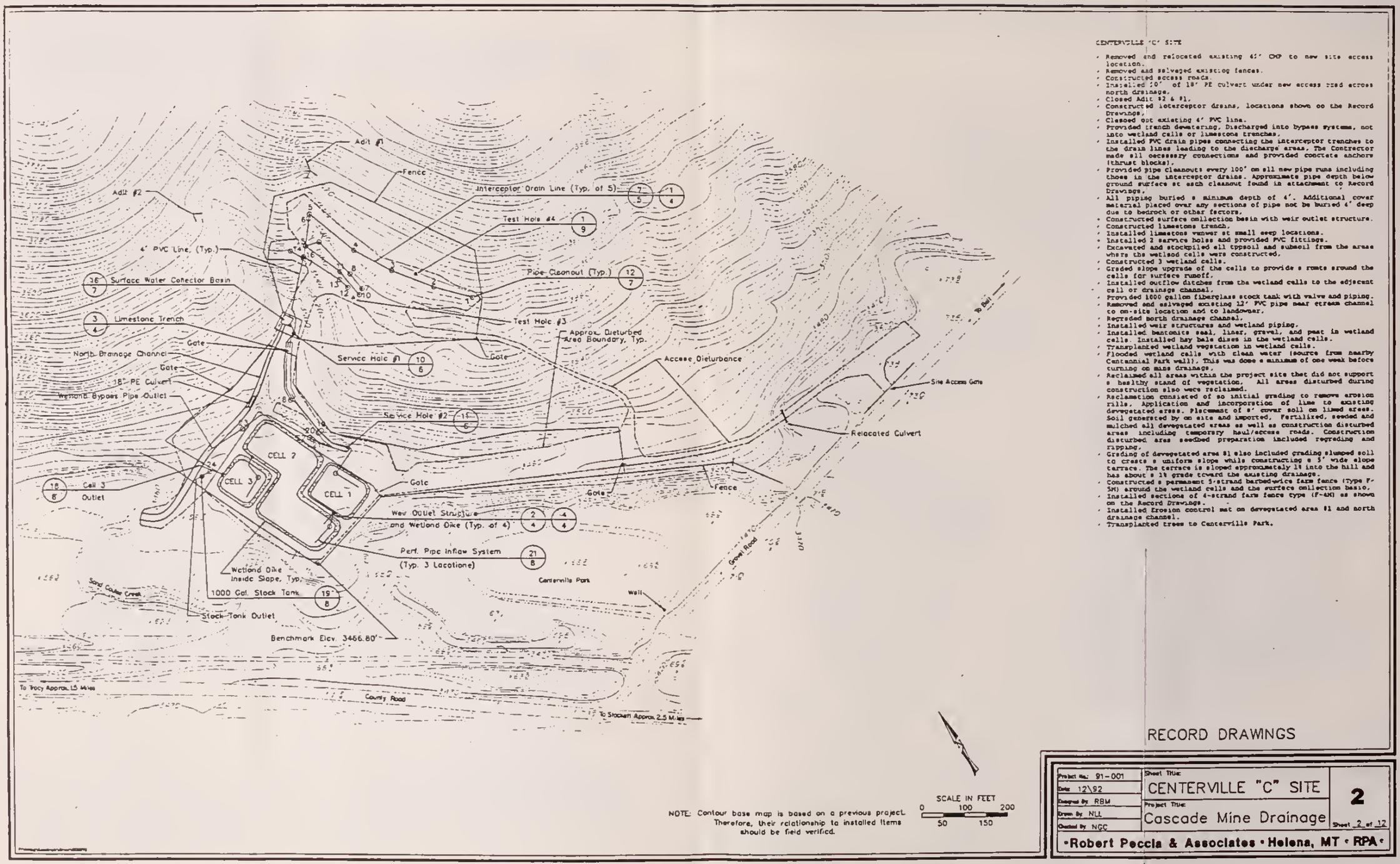
A plan drawing of the Centerville "C" Wetland is provided in Figure 3.1. The effective treatment area of the wetland is approximately 1.0 acres and it receives AMD at a rate of 5 to 10 gpm. This wetland differs from the French Coulee Wetland in several ways. First, AMD was pretreated in an anoxic limestone drain (ALD). An ALD is a buried trench filled with crushed limestone and isolated from oxygen in the air by a plastic or other impermeable liner. It is intended to add alkalinity to the AMD in a non-oxidizing environment. Second, substrate materials selected for the wetland cells included mushroom compost and pulverized limestone both of which have considerable inherent neutralization capacity. Finally, there was no distribution piping in the cells. All cells were intended to operate in upflow mode with water introduced to each cell through a short section of perforated pipe buried in a gravel subbase.

AMD was first introduced to the wetland on July 28, 1992. The first samples were collected on October 2, 1992. Additional samples were taken on November 2, 1992. Field notes do not indicate any operational problems at either of these times. On November 19, 1992 a blowout of AMD was found above the limestone trench and it was noted that no AMD was entering the wetland. Initially, it was thought that plugging of the subsurface pipe at the entry to Cell 1 was the cause of the problem. However, it was apparently discovered that both the ALD and the buried wetland inlet pipe were plugged. Flow was restored by bypassing the ALD and all inlet pipes and running the wetland in surface flow. The wetland operated in this mode during the winter. Winter operation caused ice build-up much as it did at French Coulee.

Water sampling resumed in the spring and continued through July, 1993. An attempt was made to resume operation of the ALD. However, there was a reference in field notes to Service Hole No. 1 being full of water on May 6, 1993 and June 7, 1993. Field notes again referenced plugging problems with the ALD. The ALD was bypassed on June 7 and has not been operated since.

3.2 Observations on Site Visit

The Centerville "C" site was visited on October 22, 1993. Surface soil was unusually moist (but not saturated) downgradient of the ALD indicating a possible recent discharge from the trench or associated wetland piping. However, although the ALD was bypassed, there were no current flow problems at the wetland and the wetland appeared to be functioning from the standpoint of physical flow. Flow through the wetland was all surface flow. There was about 6 inches of standing water in the bottom of Service Hole No. 1 indicating that the local water table might still be slightly elevated.



CENTERVILLE 'C' SITE

- Removed and relocated existing 4" CMP to new site access location.
- Removed and salvaged existing fences.
- Constructed access roads.
- Installed 20' of 18" PE culvert under new access road across north drainage.
- Closed Adit #2 & #1.
- Constructed interceptor drains, locations shown on the Record Drawings.
- Closed out existing 4" PVC line.
- Provided trench dewatering. Discharged into bypass systems, not into wetland cells or limestone trenches.
- Installed PVC drain pipes connecting the interceptor trenches to the drain lines leading to the discharge areas. The Contractor made all necessary connections and provided concrete anchors (thrust blocks).
- Provided pipe cleanouts every 100' on all new pipe runs including those in the interceptor drains. Approximate pipe depth below ground surface at each cleanout found in attachment to Record Drawings.
- All piping buried a minimum depth of 4'. Additional cover material placed over any sections of pipe not be buried 4' deep due to bedrock or other factors.
- Constructed surface collection basin with weir outlet structure.
- Constructed limestone trench.
- Installed limestone veneer at small seep locations.
- Installed 2 service holes and provided PVC fittings.
- Excavated and stockpiled all topsoil and subsoil from the areas where the wetland cells were constructed.
- Constructed 3 wetland cells.
- Graded slope upgrade of the cells to provide a route around the cells for surface runoff.
- Installed outflow ditches from the wetland cells to the adjacent cell or drainage channel.
- Provided 1000 gallon fiberglass stock tank with valve and piping.
- Removed and salvaged existing 12" PVC pipe near stream channel to on-site location and to landowner.
- Regraded north drainage channel.
- Installed weir structures and wetland piping.
- Installed bentomite seal, liner, gravel, and peat in wetland cells. Installed hay bale dikes in the wetland cells.
- Transplanted wetland vegetation in wetland cells.
- Flooded wetland cells with clean water (source from nearby Centennial Park well). This was done a minimum of one week before turning on mine drainage.
- Reclaimed all areas within the project site that did not support a healthy stand of vegetation. All areas disturbed during construction also were reclaimed.
- Reclamation consisted of an initial grading to remove erosion rills. Application and incorporation of lime to existing revegetated areas. Placement of 6" cover soil on limed areas. Soil generated by on site and imported. Fertilized, seeded and mulched all revegetated areas as well as construction disturbed areas including temporary haul/access roads. Construction disturbed area seedbed preparation included regrading and ripping.
- Grading of revegetated area #1 also included grading slumped soil to create a uniform slope while constructing a 5' wide slope terrace. The terrace is sloped approximately 1% into the hill and has about a 1% grade toward the existing drainage.
- Constructed a permanent 3-strand barbed-wire farm fence (Type F-3M) around the wetland cells and the surface collection basin.
- Installed sections of 4-strand farm fence type (F-4M) as shown on the Record Drawings.
- Installed erosion control mat on revegetated area #1 and north drainage channel.
- Transplanted trees to Centerville Park.

RECORD DRAWINGS

Project No.: 91-001	Sheet Title: CENTERVILLE "C" SITE
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Designed By: RBM	2
Drawn By: NLL	Sheet 2 of 12
Checked By: NGC	

•Robert Peccia & Associates • Helena, MT • RPA•

Figure 3.1 Centerville "C" wetland plan.

3.3 Water Quality Data Review

There has been no prior interpretation of data collected at Centerville during the first year of operation. Data collected to date is tabulated in Appendix A. Original analytical data reports are also in Appendix A. The following interpretations of the data are offered:

- Significant alkalinity has been available to AMD at Centerville throughout its operating history (see Figure 3.2). Several of the data points indicate calcium concentrations approaching 800 mg/l which, at SO_4^{-2} concentrations averaging 2500 mg/l, is indicative of saturation with gypsum. Data suggest that initially the primary source of calcium was the ALD. However, more recently as the ALD has become plugged and has been bypassed, calcium seems to be available from the substrate. Magnesium was also available early in the operation but appears to be primarily from substrate materials.

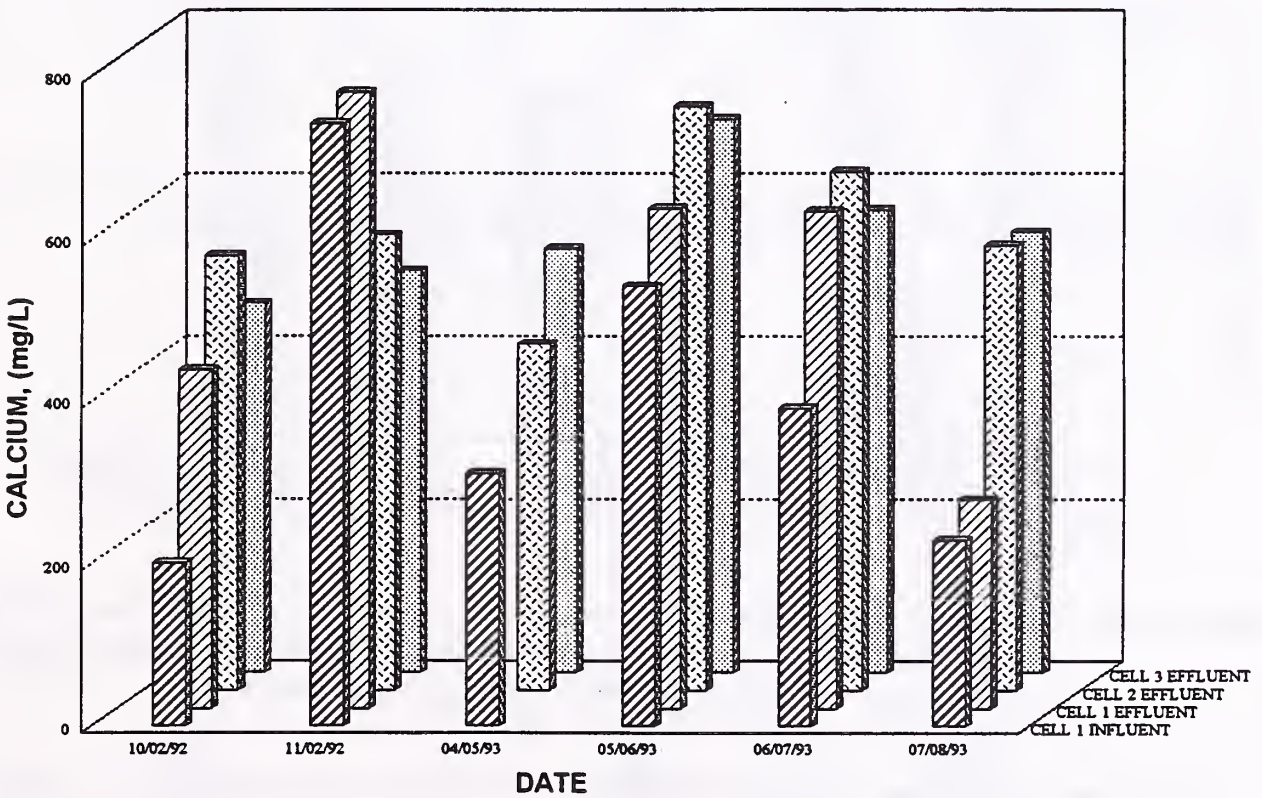


Figure 3.2. Calcium concentrations in water samples from the Centerville "C" wetland.

- Sulfate concentrations generally decrease across the wetland from cell to cell. This is accompanied by reductions in Al and Fe concentrations and represents a transition to water chemistry in which sulfate concentration appears to be determined principally by gypsum solubility.

- On the first few sampling dates, there was a poor correlation between analyzed TDS and the sum of analyzed constituents in effluent from the wetland. These periods were marked by high pH and it is possible that bicarbonate (not analyzed in this study) chemistry was significant during these periods. Dissolved organic materials from the substrate may also have contributed to this imbalance.

- The influent AMD is decidedly well oxidized at Centerville based on the ferrous/ferric analyses (see Figure 3.3). This is not the best water to treat in an ALD since ferric iron will precipitate at pH's buffered by carbonate water chemistry. In spite of the wetland's operation in crossflow mode, water often leaves the wetland with residual iron present predominantly as ferrous iron.

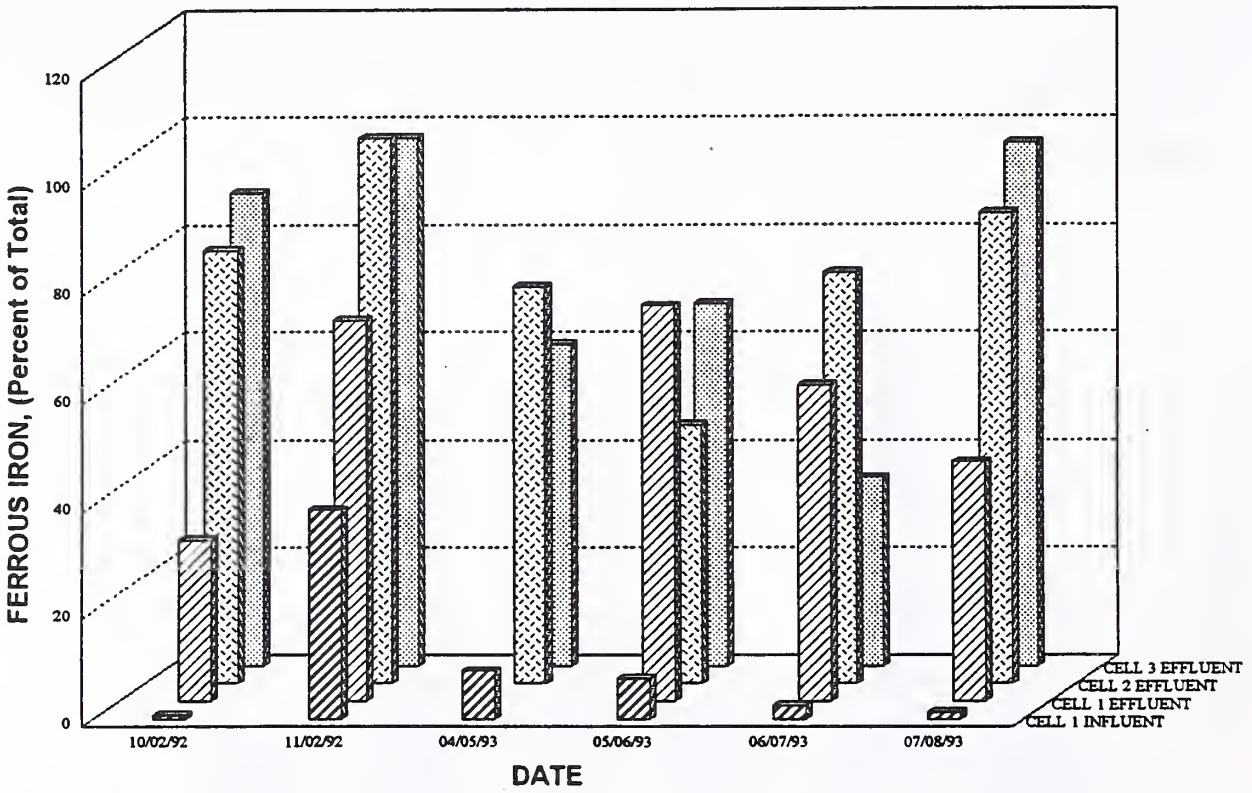


Figure 3.3 Chemical reduction of iron at the Centerville wetland. Ferric iron is predominant in the influent AMD but ferrous iron predominates in the low level residual iron leaving the wetland.

- High levels of Al and Fe removal have been achieved throughout the operating period of the Centerville Wetland (see Figures 3.4 and 3.5). However, on the final sample date (7/8/93) a breakthrough appears to have occurred in Cell 1 with the pH measured at 2.9. Not only is existing soluble iron not being precipitated but previously precipitated material seems to be redissolving. Similar breakthroughs in successive cells may occur as readily available alkalinity in the substrate becomes depleted.

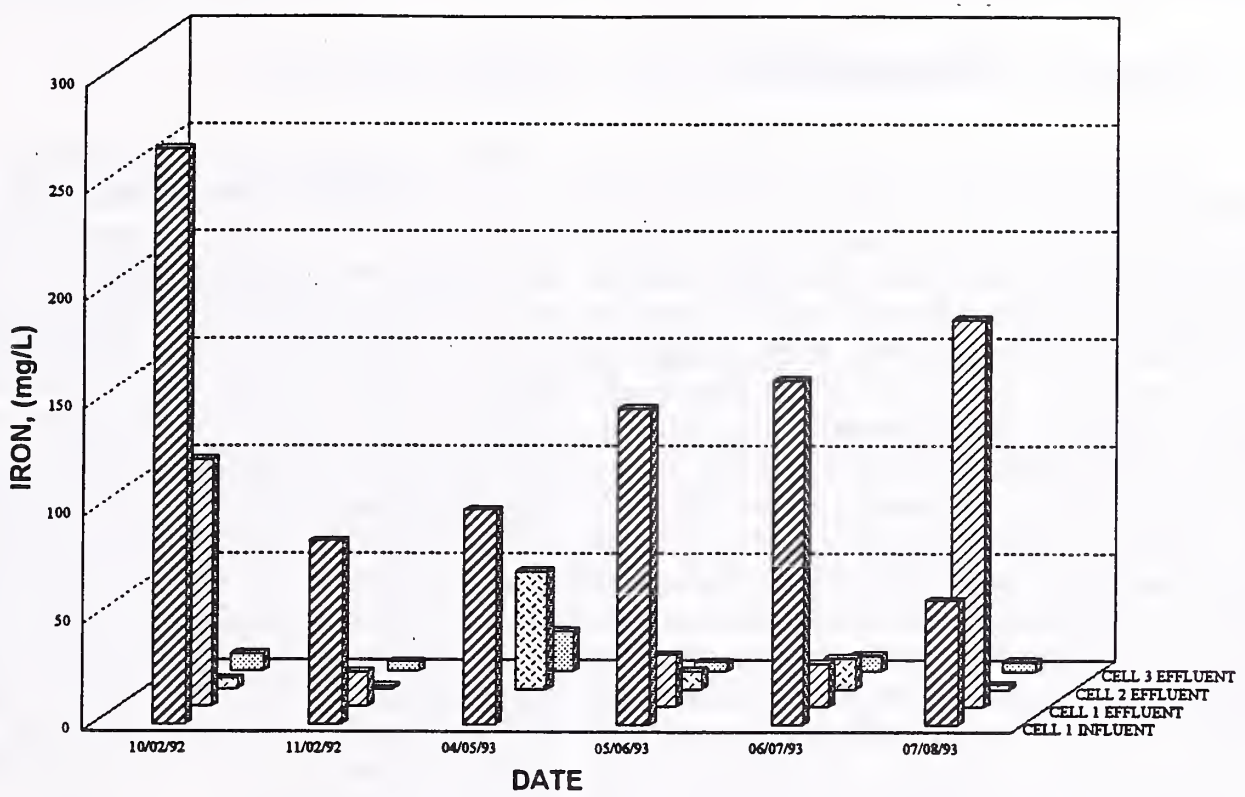


Figure 3.4 Iron concentrations in water samples from the Centerville "C" wetland. Recent data indicates that Cell 1 is beginning to fail.

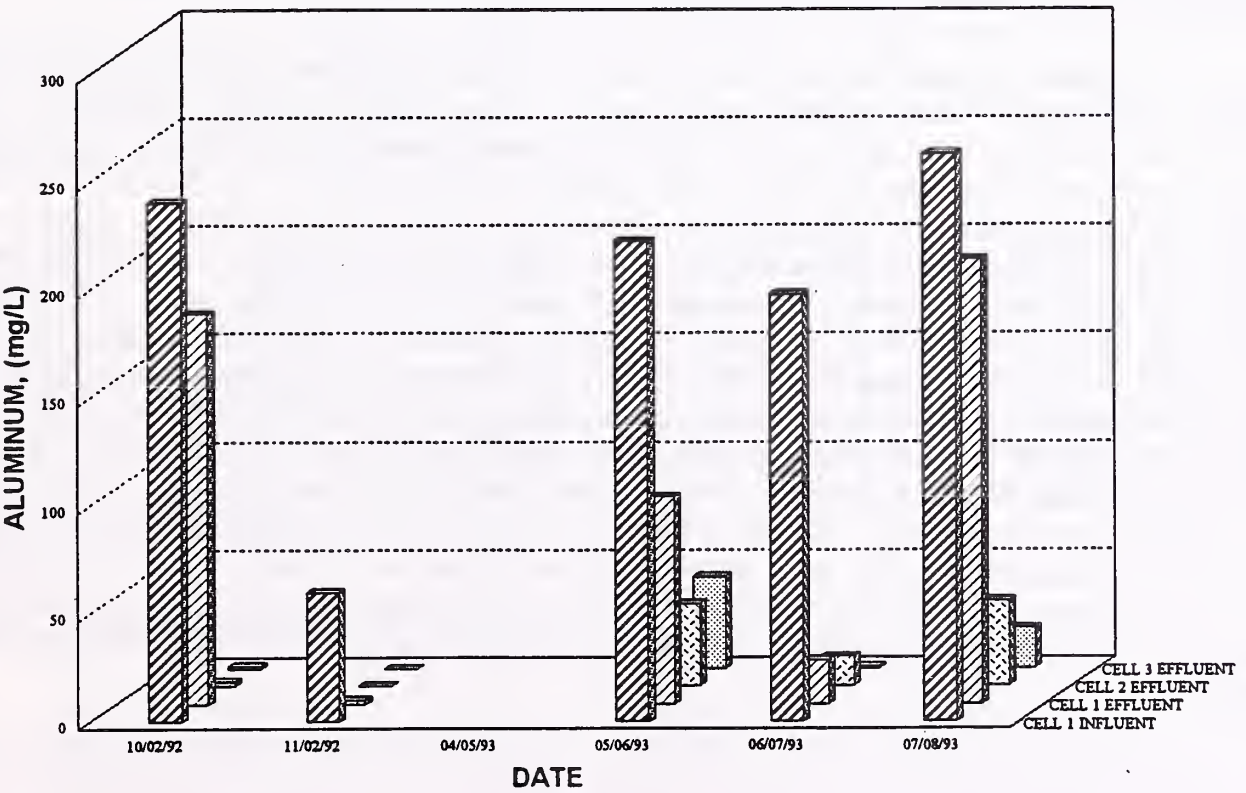


Figure 3.5 Aluminum concentrations in water samples from the Centerville "C" wetland.

3.4 Vegetation Assessment

The reseeding activities for the Centerville wetland began in June 1992 and were completed in July 1992. Recommended seeding dates are from October 15 to May 15. The method used was drill seeding. Visual observation of the reseeded areas include nearby pastures, pond corridors and banks. All areas demonstrated high seedling establishment, density, and cover. The area surrounding the cells demonstrates a high diversity of native forbs. Due to grazing prior to this evaluation a complete species list was not developed. Volunteer grass species growing from the hay bales used as diversion channels included timothy and orchardgrass. The pH requirements for both species is 5.0 to 8.0. Windblown willow branches from nearby trees are growing in the wet banks surrounding Cell 3. Russian olive seedlings look promising on the upland banks of the cells. On the drier upland areas, sheep fescue, western wheatgrass, streambank wheatgrass, Basin wildrye, and yellow sweetclover were the dominant components of the pasture. Plant density and cover were notably higher in the areas surrounding the cells. The steeper slopes contain tall skeletons of yellow sweetclover and wild parsley which dominate the vegetative cover. The recommended seeding rate of yellow sweetclover to be used in a mix is one-half pound per acre. The rate used for this project was two pounds per acre. Although, the heavy growth of yellow sweetclover can be unsightly, it is an effective nitrogen fixing legume and other species eventually tend to displace it.

Young leafy spurge plants were present in several areas surrounding the cells at Centerville. This weed problem can be controlled by spraying with Tordon mixed at half strength as to not damage young grasses.

The cattails planted in the cells were planted from nursery stock imported from Oregon. Overall, the survival and appearance of the cattails appears promising. The cattails look healthy, with good color and large mature seedheads. The west end of Cell 2 is the only area where the cattails do not appear to be thriving. This may be due to the contractor allowing some of the plants to dry out at times during planting. Wheatgrass was a common species noted along the wet edges of the banks. The wetlands at Centerville represent a more diverse plant community within the cells compared to French Coulee. Native species associated with natural wetlands such as rush, smartweed, and bulrush species were observed. Whether these species were imported with the cattails, with straw bales or other materials that were used on site or were simply established normally is not clear. A monitoring program to establish vegetative sampling over the next 2 to 3 years for this newly constructed wetland would be useful. The program would include: visual observation of the cattails appearance and density, diversity of wetland species, and monitoring of elemental plant uptake to provide a baseline database for use in evaluating the health of the vegetation. Literature indicates that high metal concentrations in the water start to be reflected in wetland plants after two years.

4.0 STOCKETT SE WETLAND

4.1 Operational History

The Stockett linear wetland construction began in the fall of 1991 and was completed in the summer of 1992. Robert Peccia and Associates was Engineer and Construction Inspector for the project and Sharbono Construction was Contractor.

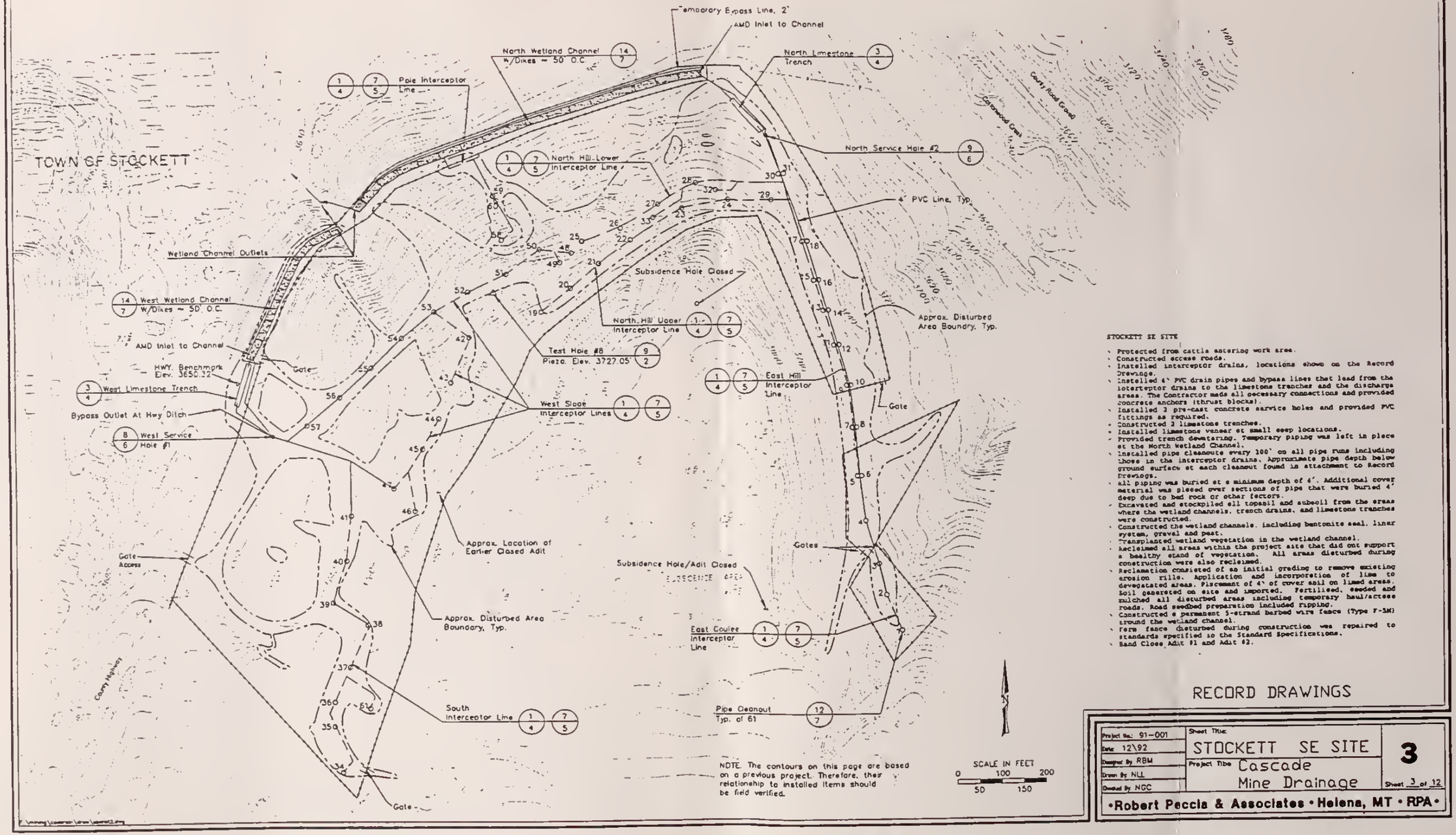
A plan drawing of the Stockett Wetland is provided in Figure 3.1. This wetland consists of two linear plastic-lined drainage channels which discharge at a common drainage point. The total effective treatment area of the channels is estimated at less than 0.1 acres. Total AMD flow of the system is about 5 gpm. Each channel is fed by interceptor drains on the hillside above and each collected AMD stream was pretreated in an anoxic limestone drain. Cattails were planted in the lined ditch to provide additional treatment and aesthetic benefits. However, as noted in Section 4.4, none of these cattails have survived. Original plans called for alternative work which included construction of a wetland cell below the drainage channels. This work has not been undertaken.

Before the treatment system was completed, problems were encountered with some of the interceptor drains. Leakage was reported at cleanouts No. 39 and No. 57, both of which are installed on interceptor trenches supplying the West Wetland Channel. These cleanouts were excavated and reinstalled. The excavation revealed that the 4 inch perforated drain pipe at cleanout No. 39 had collapsed. Precipitation of iron oxides was responsible for the blockage at Cleanout No. 57 and improper pipe installation was cited as the initiating cause. However, the exact nature of the improper installation is not specifically discussed in the final project report.

AMD was first introduced to the Stockett treatment system on July 28, 1992. The first samples were collected on September 3, 1992. Additional samples were taken on October 2 and November 2, 1992. Since there was no evidence of treatment in the North ALD, increasing fouling in the West ALD and an observed blowout at the Centerville ALD, the ALDs were bypassed for winter operation on or about November 19, 1992. ALD operation was resumed in the spring of 1993 (date uncertain) and samples from the West ALD were collected on 4/5/93. However, flow was returned to bypass mode (date uncertain) because of continuing problems due to flow restriction and decreasing chemical performance.

4.2 Observations on Site Visit

The Stockett site was visited on the afternoon of October 22, 1993. The hillsides above the drainage ditches were very wet, especially on the north side. Water was flowing at the surface in some areas. Cleanout No. 29, on the North Wetland Channel collector system, was leaking water. Since this is the last cleanout in a branch before AMD enters the collection header, this indicates a possible problem for the entire area serviced by that branch. It is not clear from drawings whether downgradient piping is perforated or solid wall. But, there is definite indication that there is a blockage of some sort in this


Temporary Bypass Line, 2"
AMD Inlet to Channel
North Wetland Channel w/Dikes - 50' O.C.
North Limestone Trench
Pole Interceptor Line
TOWN OF STOCKETT
North Service Hole #2
North Hill Lower Interceptor Line
4" PVC Line, Typ.
Wetland Channel Outlets
Subsidence Hole Closed
West Wetland Channel w/Dikes - 50' O.C.
Approx. Disturbed Area Boundry, Typ.
North Hill Upper Interceptor Line
AMD Inlet to Channel
HWY. Benchmark Elev. 3650.32
Test Hole #8
Piezo. Elev. 3727.05'
East Hill Interceptor Line
Gate
West Limestone Trench
West Slope Interceptor Lines
Bypass Outlet At Hwy Ditch
West Service Hole #1
Approx. Location of Earlier Closed Adit
Gate Access
Subsidence Hole/Adit Closed
Approx. Disturbed Area Boundary, Typ.
East Coulee Interceptor Line
Gates
South Interceptor Line
Pipe Cleanout Typ. of 61
Gate
NOTE: The contours on this page are based on a previous project. Therefore, their relationship to installed items should be field verified.
SCALE IN FEET
0 100 200
50 150
Cottonwood Creek
County Road (Gravel)
County Highway

STOCKETT SE SITE

- Protected from cattle watering work area.
- Constructed access roads.
- Installed interceptor drains, locations shown on the Record Drawings.
- Installed 6" PVC drain pipes and bypass lines that lead from the interceptor drains to the limestone trenches and the discharge areas. The Contractor made all necessary connections and provided concrete anchors (thrust blocks).
- Installed 2 pre-cast concrete service holes and provided PVC fittings as required.
- Constructed 3 limestone trenches.
- Installed limestone veneer at small seep locations.
- Provided trench dewatering. Temporary piping was left in place at the North Wetland Channel.
- Installed pipe cleanouts every 100' on all pipe runs including those in the interceptor drains. Approximate pipe depth below ground surface at each cleanout found in attachment to Record Drawings.
- All piping was buried at a minimum depth of 4'. Additional cover material was placed over sections of pipe that were buried 4' deep due to bed rock or other factors.
- Excavated and stockpiled all topsoil and subsoil from the areas where the wetland channels, trench drains, and limestone trenches were constructed.
- Constructed the wetland channels, including bentonite seal, liner system, gravel and peat.
- Transplanted wetland vegetation in the wetland channel.
- Reclaimed all areas within the project site that did not support a healthy stand of vegetation. All areas disturbed during construction were also reclaimed.
- Reclamation consisted of an initial grading to remove existing erosion rills. Application and incorporation of lime to devegetated areas. Placement of 4" of cover soil on limed areas. Soil generated on site and imported. Fertilized, seeded and mulched all disturbed areas including temporary haul/access roads. Road seedbed preparation included ripping.
- Constructed a permanent 5-strand barbed wire fence (Type F-5W) around the wetland channel.
- Farm fence disturbed during construction was repaired to standards specified in the Standard Specifications.
- Sand Close Adit #1 and Adit #2.

RECORD DRAWINGS

Project No.: 91-001	Sheet Title: STOCKETT SE SITE
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Designed by RBM	3
Drawn By NLL	Sheet 3 of 12
Checked By NGC	

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Figure 4.1. Stockett SE wetland plan.

immediate area or downstream. There was evidence of prior flow in some areas no longer flowing actively and one area of significant slope failure was noted east of Cleanout No. 29. Surface flow was collecting in an unlined ditch on the east side of the site eventually flowing into the lined North Wetland Channel.

The outlet of the North Wetland Channel, which flows laterally on a steep sideslope, appeared to be attempting to cut a new channel with a more direct path down the hillside where it discharges. There may eventually be erosion problems here which impact the stability of the channel at its discharge end.

Specifications had called for peat to be placed in the channels. However, there was little or no soil material in the channels, only rocks which were placed to create 1 foot high dams at 50 foot intervals.

Water samples were not collected at this site since AMRB was planning a routine quarterly sample soon.

4.3 Data Review

There has been no prior interpretation of data collected at Stockett during the first year of operation. Data collected to date is tabulated in Appendix C. Analytical reports are also appended. The following observations are offered:

- There is no evidence that there has ever been effective treatment in the North Limestone Trench. This is somewhat confusing since there is definite evidence of treatment in the calcium analyses for the West Limestone Trench in the early period of operation (compare Figures 4.2 and 4.3). Effective treatment is also indicated by higher pH, and decreased iron, aluminum and TDS. This must be indicative of some sort of physical installation or operational problem that is causing AMD to bypass the North Limestone Trench. There are two collection headers indicated on construction drawings for the North Wetland Channel (see Figure 4.4). One header was to be connected to interceptor drains carrying water with "high oxygen" content and was to bypass the ALD. The other was to carry water with "low oxygen" content which could be treated in the ALD or bypassed by valve actuation. Plans are unclear which interceptors were connected to which header and the positions of the two headers in Service Hole No. 2 are reversed in the bid drawings and as-built drawings. There were also significant changes in the interceptor trench design during construction. Clearly there is the possibility of some confusion here that may or may not have been resolved satisfactorily in the field. It is not clear from collected flow data how much of the total flow into the North Wetland Channel bypasses the ALD. Analytical data suggests that most or all of the flow is through the "high oxygen" header around the ALD. Similar provisions for separation of "high oxygen" and "low oxygen" water were not made on the West Wetland Channel interceptor drains (see Figure 4.5). A single header is used there and flow bypassed around the ALD is delivered to the channel in a separate pipeline. It is much easier to visually determine whether flow is treated in the ALD or not.

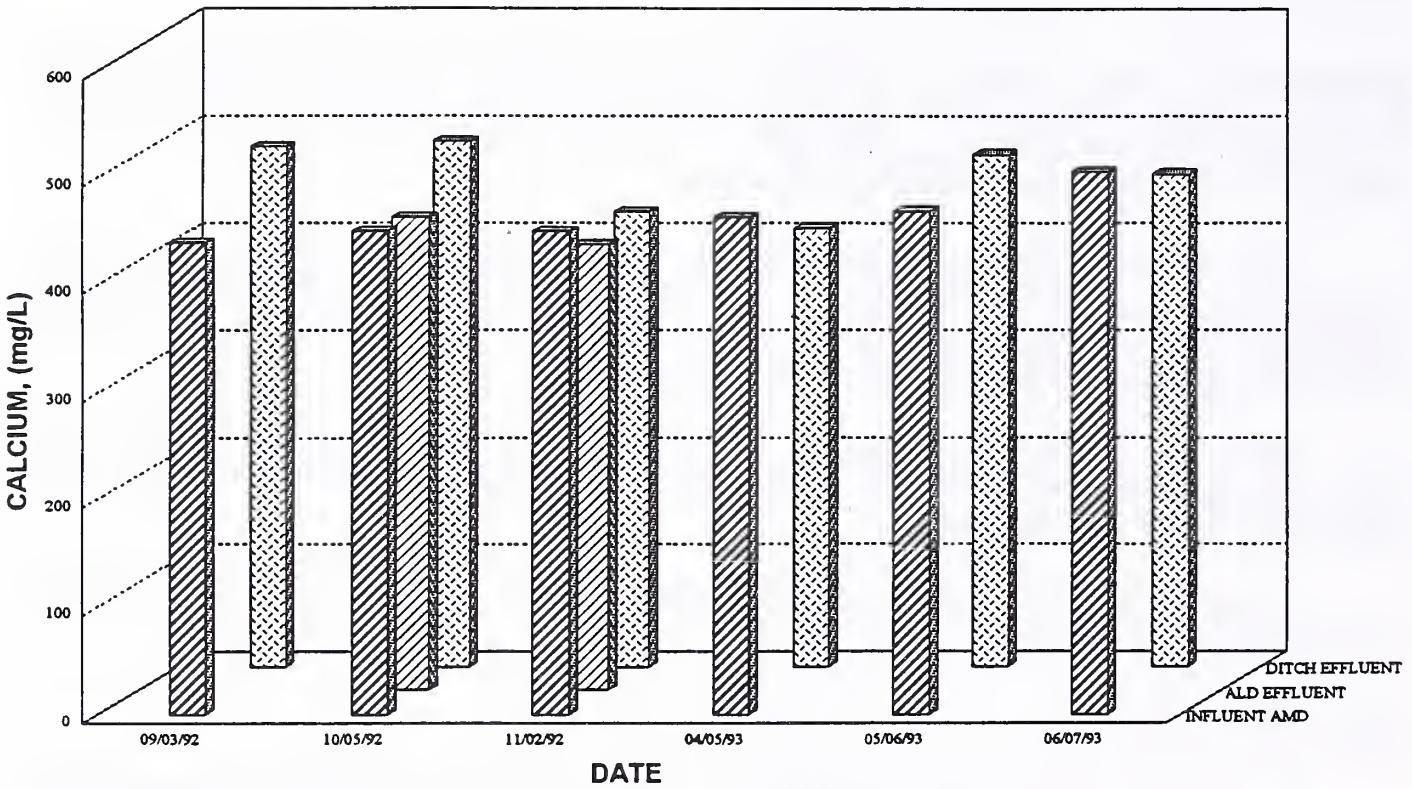

Figure 4.2. Calcium concentrations in water samples from the Stockett SE wetland north collection system. No significant treatment is being achieved.

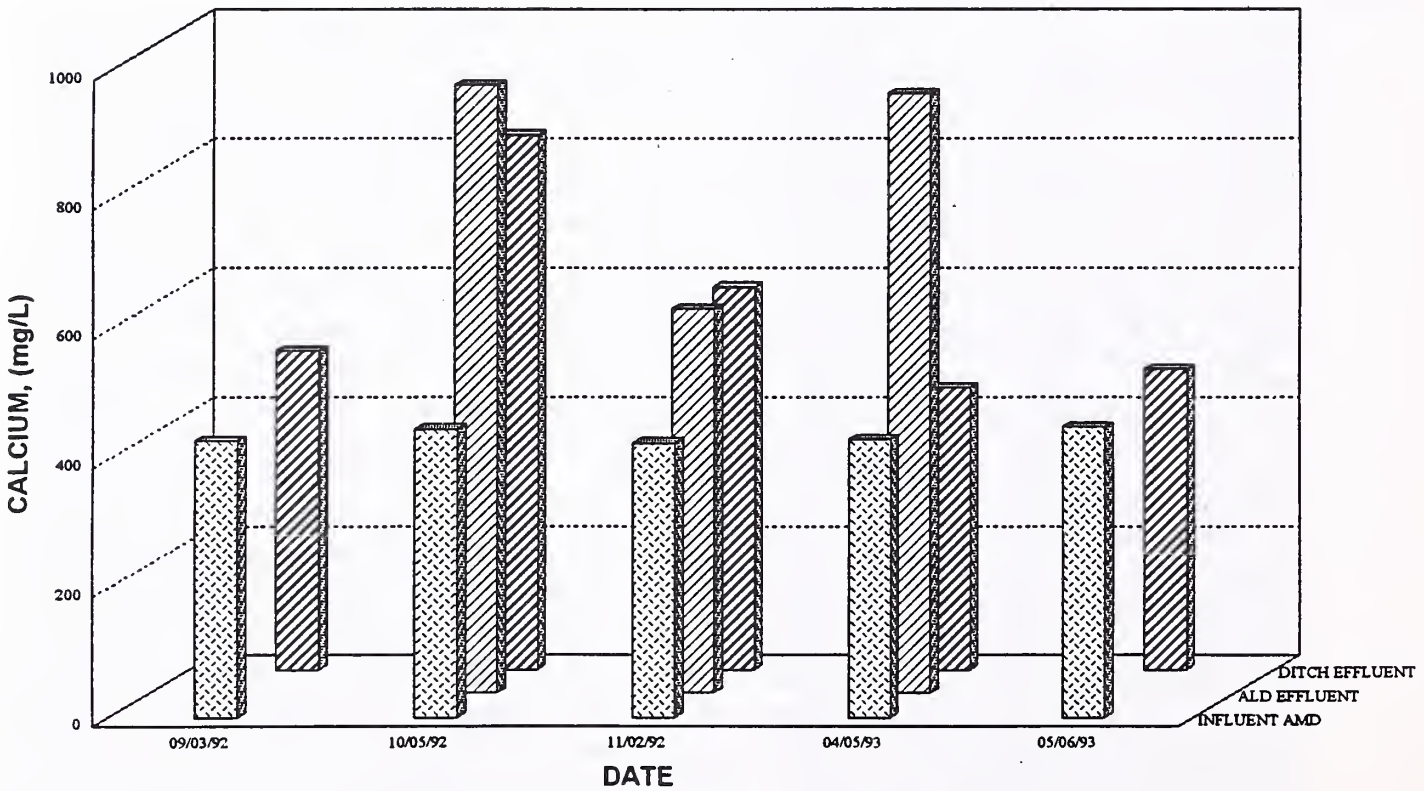

Figure 4.3. Calcium concentrations in water samples from the Stockett SE wetland west collection system. The ALD provided treatment until plugging caused failure.

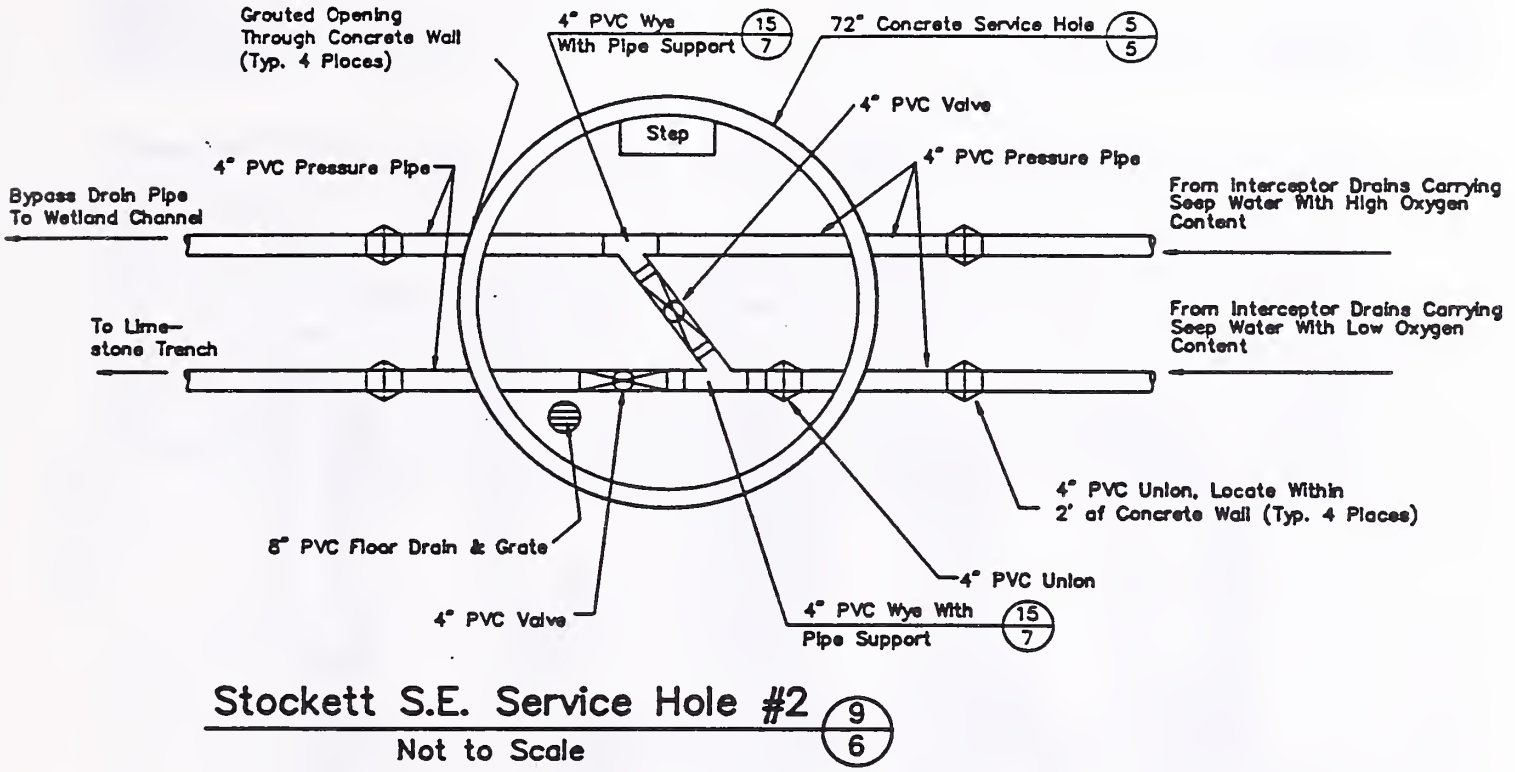
Grouted Opening Through Concrete Wall (Typ. 4 Places)
4" PVC Wye With Pipe Support 15/7
72" Concrete Service Hole 5/5
4" PVC Valve
Step
4" PVC Pressure Pipe
4" PVC Pressure Pipe
Bypass Drain Pipe To Wetland Channel
From Interceptor Drains Carrying Seep Water With High Oxygen Content
To Lime-stone Trench
From Interceptor Drains Carrying Seep Water With Low Oxygen Content
4" PVC Union, Locate Within 2' of Concrete Wall (Typ. 4 Places)
8" PVC Floor Drain & Grate
4" PVC Union
4" PVC Valve
4" PVC Wye With Pipe Support 15/7
Stockett S.E. Service Hole #2 9/6
Not to Scale

Figure 4.4. Piping arrangements in the Stockett SE north collection system. AMD appears to be bypassing the limestone trench based on analytical data.

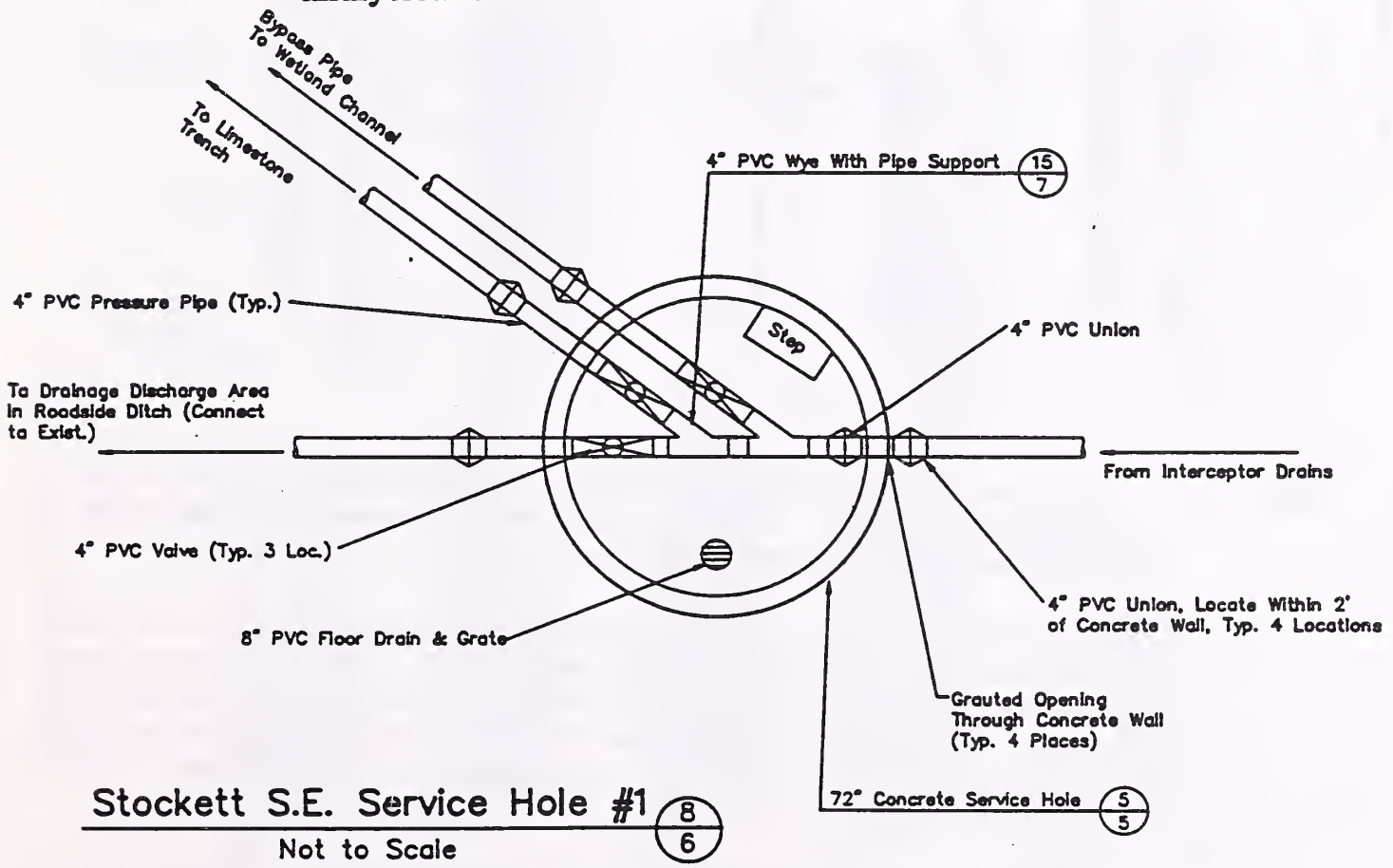
Bypass Pipe To Wetland Channel
To Limestone Trench
4" PVC Wye With Pipe Support 15/7
4" PVC Pressure Pipe (Typ.)
Step
4" PVC Union
To Drainage Discharge Area In Roadside Ditch (Connect to Exist.)
From Interceptor Drains
4" PVC Valve (Typ. 3 Loc.)
4" PVC Union, Locate Within 2' of Concrete Wall, Typ. 4 Locations
8" PVC Floor Drain & Grate
Grouted Opening Through Concrete Wall (Typ. 4 Places)
72" Concrete Service Hole 5/5
Stockett S.E. Service Hole #1 8/6
Not to Scale

Figure 4.5. Piping arrangements in the Stockett SE west collection system. This system provides better control over water flow to the limestone trench.

- Water chemistry before and after the West Limestone Trench reveals the source of plugging problems that have been encountered there. Water leaving the trench is much lower in aluminum (see Figure 4.6). Aluminum is probably being precipitated as aluminum hydroxide. Iron is also removed in the limestone trench. However, as might be expected based on established thermodynamic data, precipitation is selective for ferric iron. This is shown by the increasing ferrous content as a percentage of total iron in ALD effluent (see Figures 4.7 and 4.8) Massive quantities of SO_4^{-2} are also removed in the ALD. This is most likely precipitating as $CaSO_4$ although there is a possibility for formation of alunites (aluminum hydroxy-sulfates) and jarosites (iron hydroxy-sulfates).

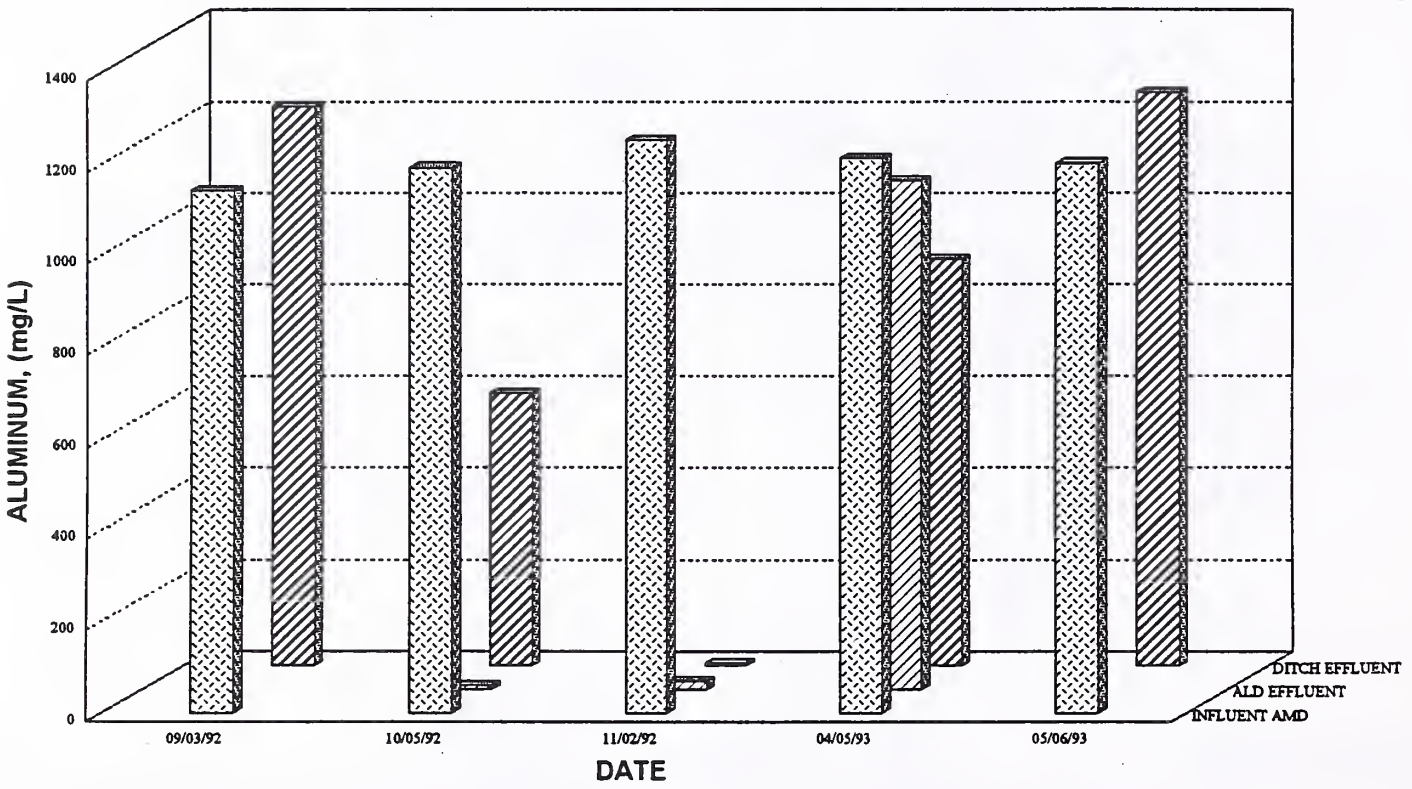

Figure 4.6 Aluminum concentrations in water from the Stockett SE west collection system. When the ALD was functioning, aluminum precipitation was nearly complete.

- Even when the West ALD was operating, it failed to contribute sufficient alkalinity to the treated water to neutralize residual soluble iron. Alkalinity values were measured between 500 and 700 mg/l $CaCO_3$ while residual total iron ranged from 600 to 1300 mg/l, primarily as ferrous iron. If oxidized and precipitated as ferric hydroxide this quantity of iron would consume all the available alkalinity and the effluent would reacidify.

- Little or no treatment is being obtained in the lined ditches. There is some increase in calcium, magnesium and manganese much the same as was seen at French Coulee and Centerville. This is probably attributable to the small amounts of substrate materials originally placed in the ditches. However, reductions in acidity, TDS, iron and aluminum are insignificant.

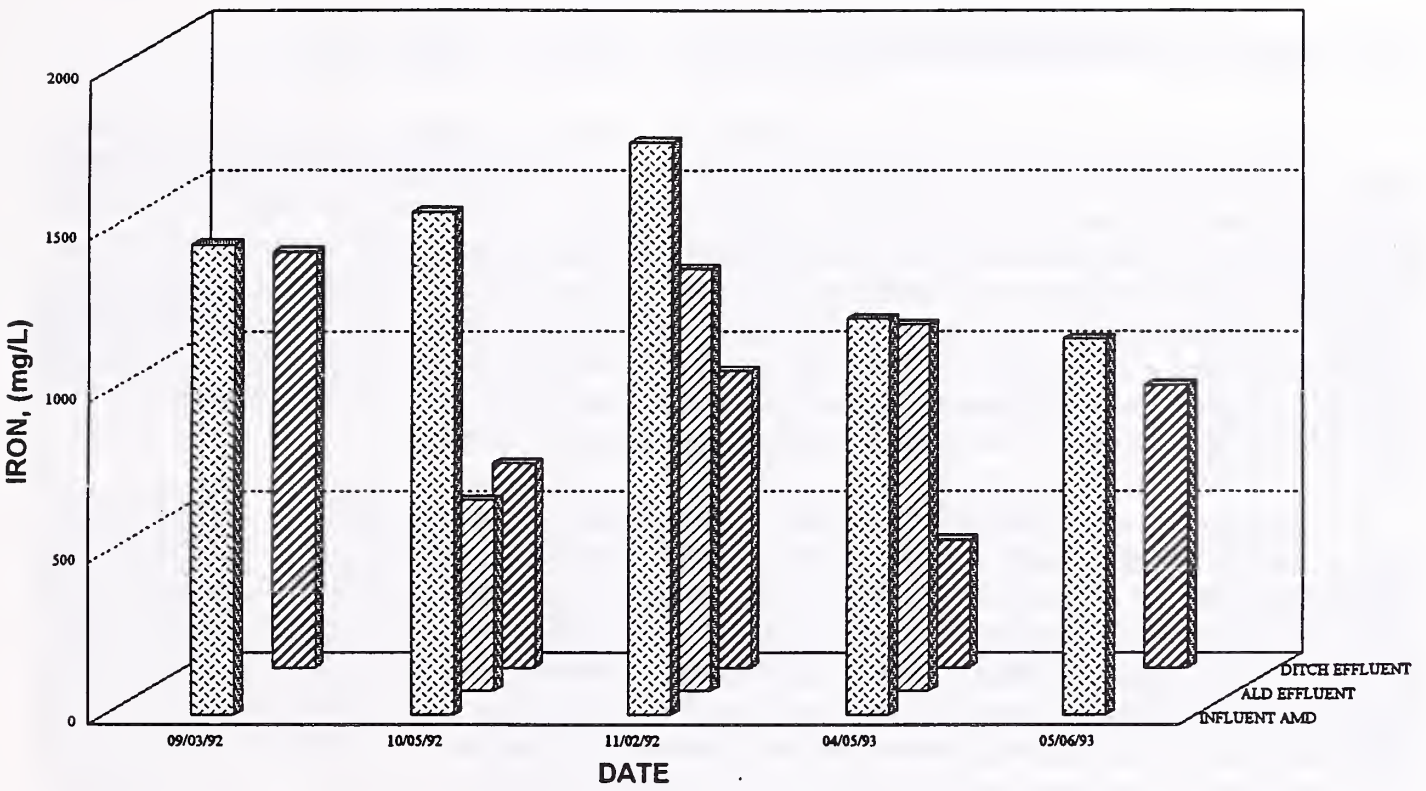

Figure 4.7. Iron concentrations in water samples from the Stockett SE wetland west collection system. The ALD provided some treatment.

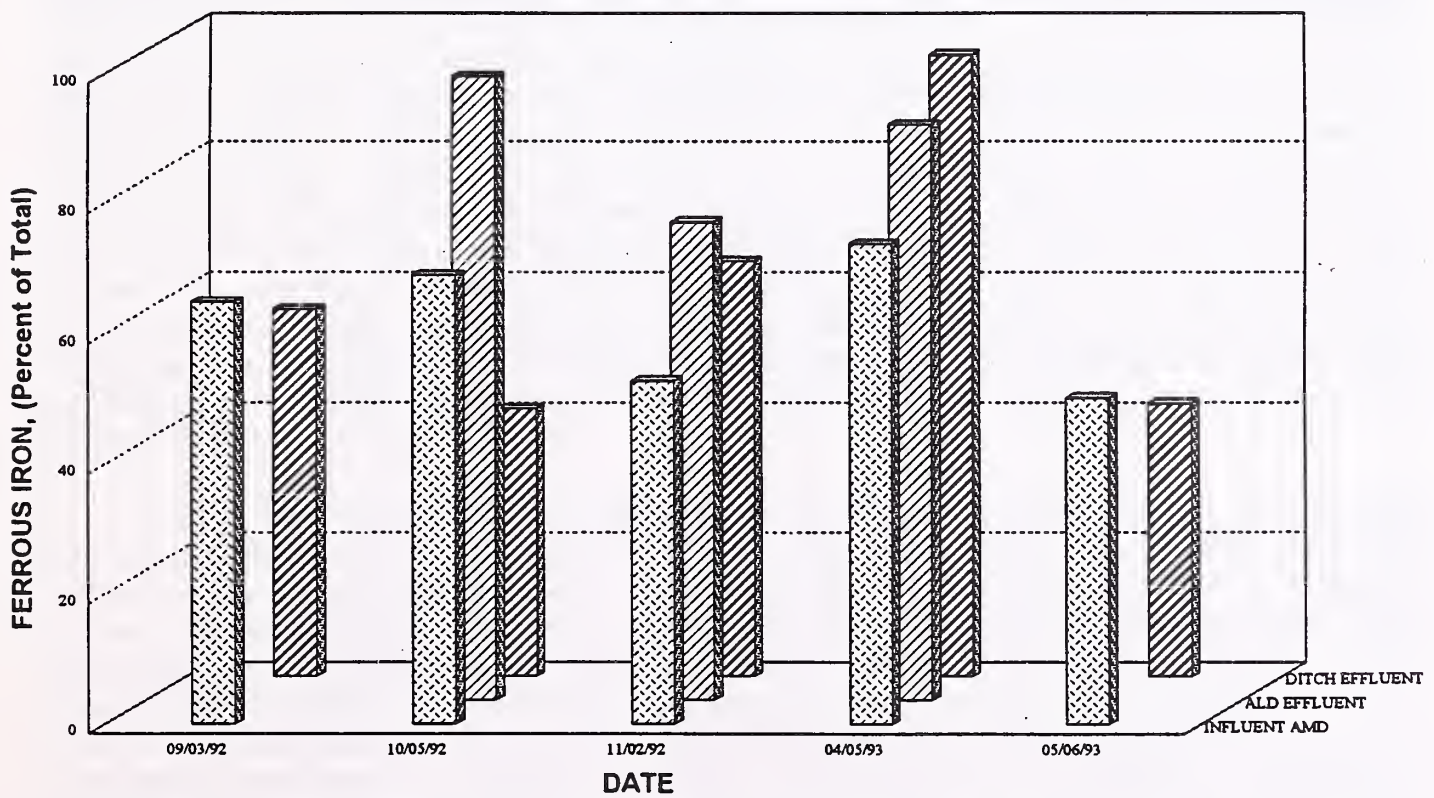

Figure 4.8. Ferrous iron in water samples from the Stockett SE wetland west collection system. The ALD was selective for ferric precipitation.

4.4 Vegetation Assessment

The seeding activities for the Stockett wetland began in late June 1992. Hydromulching, hand raking and drill seeding were all used as methods of incorporating seed, fertilizer and mulch into the soil. The vegetation established on either side of the north and south channel represents favorable seedling establishment, vigor and density. Very few weedy species were noted throughout the project area, however, field bindweed was observed along the fence at the south end. The transplanted Russian olive seedlings are thriving along the south channel. Also noted here were native snowberry and woods rose seedlings. Wheatgrass species, sheep fescue, smooth brome, Basin wildrye, yellow sweetclover and forbs were abundant along the channel banks.

The pasture area above the north channel consisted of a diverse community of sheep fescue, streambank wheatgrass, thickspike wheatgrass, bluegrass, and brome. Heavy patches of yellow sweetclover, mustard and pennycress skeletons dominated portions of the revegetated areas and perhaps crowded out grass species. Where more moisture is available, timothy, wild parsley, and streambank wheatgrass were noted. Several burn out (bare) areas were found on the upper slope above the channels where AMD had previously seeped to the surface. Overall the vegetation looked promising with the exception of the burn areas and the dense stands of yellow sweetclover and mustard.

In the wetland area, the channels were planted with cattails transplanted from mature stands. The cattails are dead and have most likely failed due to high metal levels associated with essentially untreated mine drainage and the absence of growing media.

5.0 WETLAND STATUS SUMMARY

5.1 French Coulee Status

The French Coulee Wetland has experienced frequent problems associated with flow control. Initially, with cells in upflow mode, this problem was manifested by piping inlet screens blocked by sludge and bacterial growth resulting in flows partially or largely diverted to crossflow. Clearing these blockages was rarely successful for more than two or three weeks of sustained operation. Recent operation in downflow mode seems to have reduced this problem to some extent, but the buried distribution piping itself has been found to be susceptible to plugging. Cleaning the piping system produces much improved flow conditions. Since distribution pipe cleaning has been done only once, it is not certain how long the beneficial effects will persist. Cell 1 appears to have been permanently impaired by fouling since pipe cleaning did not restore full flow capacity in this cell for treatment in downflow mode. Finally, winter operations produce yet another flow control problem in the form of ice sheets. If ice freezes completely into the substrate materials, the flow path for upflow or downflow operation will be effectively blocked. Moreover, ice sheets have reached such thickness as to divert water flow out of the flumes.

Data interpretation is difficult because of the perturbations caused by problems associated with flow control, the long detention time in the wetland, variations in AMD composition and evapotranspiration rates. However, it seems clear that the wetland is providing partial treatment of the AMD in the form of lower acidity and metal levels, especially when proper contact with substrate materials is maintained through the prevention of short-circuiting. As described in an earlier interim report (Schafer and Associates, 1992), a significant part of this treatment is due to inherent initial alkalinity and/or exchange capacity in the substrate. As this initial supply of alkalinity is exhausted, poorer chemical performance is likely. However, reduction in acidity appears to be occurring by some other mechanism as well, most likely sulfate reduction. Based on the data analysis in this report it appears that approximately 100 mg/l (as $CaCO_3$) acidity reduction was obtained in Cell 1 and 600 mg/l (as $CaCO_3$) in Cell 2 following pipe cleaning. These values were obtained when the wetland was working in a steady state condition. The level of treatment attained appears to be roughly proportional to the volume of substrate available.

Cell 3 has remained in crossflow mode for a year and an analysis of treatment efficiency was not made on this cell. However, if one assumes that a level of sulfate reduction similar to that in Cell 2 could be achieved in Cell 3 with better substrate contact, the total acidity reduction obtained for the entire wetland would only be about 1300 mg/l (as $CaCO_3$) of acidity based on concentrations measured into Cell 1. Since typical AMD acidity at French Coulee ranges between 2000 and 6000 mg/l (as $CaCO_3$), it appears that there is not sufficient treatment by this mechanism alone to provide adequate treatment for acidity reduction. Furthermore, as inherent alkalinity is consumed, there appears to be a decrease in the rate of sulfate reduction. Thus, additional loss of performance may occur in the future.

Beyond the issue of obtaining sufficient sulfate reduction, there is the question of what form sulfur would take if it is in fact reduced at rates higher than those demonstrated to date. It will not precipitate as a sulfide of aluminum. Aluminum sulfide is unstable in water, decomposing to H_2S and $Al(OH)_3$. There is insufficient iron in the AMD to accommodate all the sulfur in AMD as FeS_2. The formation of elemental sulfur is another possibility. At SO_4^{-2} concentrations greater than $10^{-1.55}$ (2705 mg/l) elemental sulfur can form but the reaction may be subject to a very high activation energy (Lindsay, 1979). There is also the potential for offgassing of H_2S. This would represent a significant emission of H_2S if complete sulfate reduction was achieved without an accompanying precipitation as metal sulfides. Finally, there may be massive quantities of iron, or other metals which form stable sulfides, available in the original substrate which could be available for fixation of sulfide if it forms.

Vegetation success at French Coulee has been mixed. Cattails in Cells 1 and 2 appear to be dying back because of the acidity and high metal content of AMD in these cells. Cattails in Cell 3 continue to do well. Grasses on slopes above the wetlands have grown well. Native shrubs which were planted at this site have mostly failed. The success of the grasses may have contributed to the failure of the shrubs but foraging by small animals may also be a factor .

5.2 Centerville "C" Status

Like the French Coulee wetland, the Centerville "C" wetland has also been prone to physical failures. Both the ALD and the water inlet piping have become fouled and are no longer functional. This has effectively taken away the two primary mechanisms for chemical treatment. Nonetheless, there has not yet been a complete failure of this wetland. The high lime content of the substrate material appears to be providing sufficient alkalinity through what must be primarily surface contact. However, this will not continue indefinitely. Cell 1 showed signs of failure on the last recorded sampling date. Without effective AMD contact with substrate, it is anticipated that the other cells will eventually fail in the same manner. Ice formation is also a problem at Centerville for maintaining proper water flow control.

Vegetation is doing quite well at the Centerville site. Cattails are thriving although they are somewhat sparse in Cell 2. The high lime content of the substrate material may be a contributing factor to their success. Revegetated areas in the AMD collection areas have grown in well and do not currently appear to be impacted by AMD. However, problems with interceptor drains of identical design have been encountered at Stockett and could develop here as well over time.

5.3 Stockett SE Status

The Stockett SE site has been prone to numerous problems of various kinds and virtually nothing is working properly. Interceptor drains have failed apparently from both fouling and collapse and this has resulted in seeps emerging on newly reclaimed areas on the hillsides. The North ALD has not provided any evidence of treatment and it is suspected that most water collected on this side of the site is diverted around the ALD in a pipeline installed for highly oxidized AMD. The West ALD appeared to function for

a time, but it gradually fouled and has been abandoned. Judging from the decrease in aluminum and ferric iron concentrations across the West ALD while it was operating, precipitation of these metals is the probable cause of failure. The wetland channels do not demonstrate any significant degree of water quality improvement. In the winter the channels fill with ice. So far this has not resulted in a diversion of water out of the channel but that possibility exists in an especially severe winter.

Vegetation success at Stockett has been poor. None of the cattails planted in the channels have survived. In areas where new seeps are emerging because of failed interceptor drains, burnouts are occurring.

5.4 Assessment of Performance

Performance of the wetlands needs to be evaluated in two ways. First, the capacity of the wetlands to reduce acidity, metal concentrations and other constituents, especially relative to water quality standards, needs to be addressed. Second, the reliability of the systems, their ability to continue functioning with minimal maintenance, should be evaluated.

5.4.1 Reduction of Constituents

Table 5.1 shows the current level of treatment being obtained in each of the wetlands. The table shows that the Stockett system is providing little improvement in water quality. The only significant change is a 25 percent reduction in iron which is probably the result of oxidation and hydrolysis reactions when mine water is exposed to the air. The poor performance of this system is not surprising in view of the fact that both ALDs are no longer operational and the treatment volume provided in the lined ditches is minimal.

The French Coulee wetland shows some improvement in water quality with respect to iron, aluminum and zinc but little change in sulfate and total dissolved solids. The demonstrated sulfate reduction rates are too low to provide complete treatment. In this respect, the wetland appears to be undersized by a factor of four or more. This wetland is still not in an equilibrium condition after two years of operation as demonstrated by the increase of calcium and magnesium concentrations in the effluent water. Thus, additional loss of performance is anticipated as residual inherent alkalinity is consumed.

The Centerville C wetland shows significant improvements in most water quality parameters including iron, aluminum, zinc, sulfate and TDS. However, as noted earlier, the high initial alkalinity of the substrate materials may be responsible for most of this improvement. The wetland is definitely not in a steady-state operational mode and future loss of treatment performance should be expected.

Table 5.1 Current treatment efficiencies of the three wetlands compared.

Component	French Coulee Wetland			Centerville C Wetland			Stockett SE Wetland (West System)		
	Influent Water	Effluent Water	% Change	Influent Water	Effluent Water	% Change	Influent Water	Effluent Water	% Change
Fe (mg/l)	555.0	354.0	-36.2	58.0	5.0	-31.8	1170.0	878.0	-25.0
Al (mg/l)	290.0	173.0	-40.3	263.0	18.7	-92.9	1200.0	1250.0	4.2
Ca (mg/l)	178.0	547.0	207.3	229.0	542.0	136.7	465.0	465.0	3.3
Mg (mg/l)	91.0	141.0	55.0	95.0	178.0	30.5	290.0	290.0	1.0
Mn (mg/l)	4.9	4.9	880.0	2.54	4.55	79.1	8.38	9.72	10.3
Zn (mg/l)	2.70	1.48	-45.2	2.84	0.18	-93.7	62.8	65.4	1.0
SO_4^{-2} (mg/l)	3680	3530	-4.1	3150	2150	-31.8	15700	10600	1.9
TDS (mg/l)	5320	5070	-4.7	5020	3280	-34.7	15700	15700	3.2
pH (su)	2.4	2.6	NMF	2.7	4.4	NMF	2.6	2.6	NMF

NMF = No Meaningful Figure

Table 5.2 A comparison of effluent waters from the three wetlands with water quality standards and guidelines.

Component	Drinking Water MCLs	Fresh Water Aquatic[2] Acute/Chronic	Livestock Guidelines[3]	French Coulee Wetland Effluent Water	Centerville C Wetland Effluent Water	Stockett SE Wetland Effluent Water
				Most Recent Data	Most Recent Data	Most Recent Data
Fe (mg/l)	0.3	1.0/None	None	354.0	5.0	937.0
Al (mg/l)	None	None	None	173.0	18.7	1050.0
Ca (mg/l)	None	None	1000	547.0	542.0	435.0
Mg (mg/l)	None	None	500	141.0	124.0	258.0
Mn (mg/l)	0.05	None	None	4.9	4.6	10.6
Zn (mg/l)	5.0	.320/.047	None	1.48	0.2	65.5
SO_4^{-2} (mg/l)	250	None	1000	3530	2150	9190
TDS (mg/l)	500[1]	None	5000	5070	3280	13800
pH (su)	5 to 9	None/6.5 to 9.0	5.6 to 9.0	2.9	4.4	2.7

1 The drinking water standard sets the TDS requirement based on total sulfate plus chloride. 2 Calculated @ 100 mg/l hardness 3 Source: Water Quality, p 476.
4 A standard of .75 mg/l has been proposed for the acute standard while 0.087 has been proposed as the chronic standard.

The ability of wetland treatment systems to provide compliance with pertinent water quality standards is of interest to those contemplating wetland treatment as a means of achieving compliance. Table 5.2 compares current data for measured components for the three wetlands with drinking water, fresh water aquatic life standards and guidelines for livestock water. The table indicates that none of the systems is able to meet any of the standards listed. The standards for SO_4^{-2} and pH appear to be the most difficult to meet. In fact, because of the relatively high solubility of gypsum ($CaSO_4$), any system relying on neutralization with lime or limestone will be unable to comply with even the livestock guideline listed. Other constituents like iron require very high removal efficiencies (99.9+ percent) to bring water into compliance with the drinking water standard. Thus, even if a very significant level of metal removal were to be achieved it might not be sufficient to meet applicable standards. Consequently, wetlands cannot be recommended as a technology for AMD treatment when any of these water quality standards must be met and water quality is as poor as it was on these three sites.

The reader is cautioned that both the French Coulee and Centerville C wetlands are not believed to be completely stabilized at a sustainable treatment rate and that the partial treatment levels indicated in Table 5.2 may continue to decline in future.

5.4.2 System Reliability

Wetlands for AMD treatment have been promoted as passive systems requiring minimal maintenance and operating costs. At sites where metal loading and acidity are low and treatment is by surface flow only, this may be true. However, at the sites evaluated in this report this has not been the case. Buried underground collection and distribution piping have been a source of problems at all three sites. The high level of dissolved solids produces copious quantities of inorganic precipitates which settle in the piping. The problem appears to be compounded by the growth of bacterial slime.

Similar fouling was experienced in the anoxic limestone drains constructed at Centerville C and at Stockett. Because of the high levels of aluminum, ferric iron and sulfate, all of which will precipitate as AMD is neutralized with limestone, rapid plugging of the ALDs has occurred. Utilization of this technology on water of the poor quality found at these sites cannot be recommended.

Finally, the severe winter weather conditions in Montana make winter operation difficult or impossible. Freezing is usually so extensive that proper flow control is lost. The result has been loss of physical contact with substrate materials and even loss of containment within treatment areas. It is believed that treatment attributable to biological activity also decreases in cold weather but no data has been collected at these sites to evaluate this.

5.5 Recommended Actions

There appear to be few opportunities to remedy the performance of the Stockett system. Maintenance action on the ALD is not recommended. The ferric iron, aluminum and sulfate concentrations are simply too high to operate the ALD without precipitating massive quantities of solids and causing fouling. Depending on the cause of failures in the collection system, it may be possible to fix some of the problems with the leaking collection system. This would help to control the erosion and slope failure which is

occurring on the hillside and prevent additional damage to what appeared to be an initially successful reseeding effort.

Continued maintenance of the distribution piping appears to be essential for sustaining the partial treatment that is being achieved at French Coulee. It would be useful to better define the rate of sulfate reduction occurring at this site. It is still not possible using available data to accurately determine the sustainable rate of sulfate reduction/removal with existing data. At lower flow rates, the treatment response should be more pronounced. The usefulness of this figure would be to establish a meaningful sizing criterion. These wetlands are already known to require large areas of land and substantial capital investments. It may very well be that treatment rates can be shown to be so low as to render these systems uneconomical even if they did function properly.

At Centerville, it would be useful to attempt to restore the functionality of the buried inlet piping. The piping may have fouled largely because of precipitates forming in the ALD. If successful, this action would restore a significant capacity for chemical treatment by neutralization and sulfate reduction. However, these systems are very prone to fouling and a continuing maintenance program would undoubtedly be required. As at the Stockett site, maintenance action on the ALD is not recommended, particularly because of the high ferric content of the water at this site.

6.0 REFERENCES

Calabrese, J.P, Sexstone, A.J., Bhumbla, D.K, Bissonnette, G.K. and Sencindiver, J.C. 1991. Application of constructed cattail wetlands for the removal of iron from acid mine drainage, *in* Proceedings of the Second International Conference on the Abatement of Acidic Drainage, Montreal, v. 3, pp. 559-586.

Dvorak, D. H., Edenborn, H.M., Hedin, R.S. and McIntire, P.E. 1991. Treatment of metal-contaminated water using bacterial sulfate reduction: Results from pilot scale reactors, Society for Mining, Metallurgy, and Exploration, Inc., Preprint Number 91-123, 8 pp.

Girts, M. A, and Kleinmann, R.L.P. 1986. Constructed wetlands for treatment of acid mine drainage: A preliminary review, *in* Proceedings of the National Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation, Lexington, KY. pp. 165-171.

Girts, M. A., Kleinmann, R.L.P. and Erickson, P.M. 1987. Performance data on typha and sphagnum wetlands constructed to treat coal mine drainage, *in* Proceedings of the Eighth Annual Surface Mine Drainage Task Force Symposium, Morgantown, W.V.

Hedin, R. S., Hyman, D. and Hammack, R. 1988. Implications of sulfate-reduction and pyrite formation processes for water quality in a constructed wetland: Preliminary observations, *in* Mine Drainage and Surface Mine Reclamation, v. 1: Mine Water and Mine Waste, USBM Inf. Circ. IC9183, U.S. Dep. of the Int., Bur. of Mines. Washington, D.C, 00. 382-389.

Kuyucak, N., Lyew, D., St-Germain, P. and Wheeland, K.G. 1991. In situ bacterial treatment of AMD in open pits, *in* Proceedings of the Second International Conference on the Abatement of Acidic Drainage, Montreal, v. 1, pp. 335-353.

Lindsay, W. L. 1979. Chemical Equilibria in Soils, pp 288-290.

McIntire, P. E., Edenborn, H.M. and R.W. Hammack. 1990. Incorporation of bacterial sulfate reduction into constructed wetlands for the treatment of acid and metal mine drainage, *in* Proceedings of the 1990 National Symposium on Mining, Knoxville, TN.

Schafer and Associates. 1991. A bench scale evaluation of organic substrates for use in constructed wetlands for the treatment of acid mine drainage, Report to Montana AMRB.

Schafer and Associates. 1992. French Coulee Wetland - Interim Operational Status Report, Report to Montana AMRB.

Taddeo, F. J. and Wieder, R.K. 1991. The accumulation of iron sulfides in wetlands constructed for acid coal mine drainage (AMD) treatment, *in* Proceedings of the Second International Conference on the Abatement of Acidic Drainage, Montreal, v. 3, pp. 529-547.

Wieder, R.K., Lang, G.E. and Whitehouse, A.E. 1985. Metal removal in sphagnum-dominated wetlands: experience with a man-made wetland system, *in* Proceeding Wetlands and Water Management on Mined Lands, University Park, PA, pp. 353-364. Wieder, R.K., Linton, M.N and Heston, K.P. 1990. Laboratory mesocosm studies of Fe, Al, Mn, Ca and Mg dynamics in wetlands exposed to synthetic acid coal mine drainage, Water, Air and Soil Pollution, v. 51, pp. 181-196.

APPENDIX A

French Coulee Wetland
Data Tables, Charts and Laboratory Reports

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36387
DATE: 09/30/92 crp

WATER ANALYSIS

Belt Wetland
Cell I Influent, BWW1130
Sampled 09/03/92 @ 1100
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	8550	
Total Acidity as $CaCO_3$	4400	
Calcium	467	
Magnesium	171	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	4680	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	478	
Iron	564	
Ferrous Iron	93.1	
Ferric Iron	471	
Manganese	3.64	
Zinc	1.98	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36388
DATE: 09/30/92 crp

WATER ANALYSIS

Belt Wetland
Cell I Effluent, BWW1E30
Sampled 09/03/92 @ 1100
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	8250	
Total Acidity as $CaCO_3$	4400	
Calcium	408	
Magnesium	152	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	5380	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	451	
Iron	660	
Ferrous Iron	279	
Ferric Iron	381	
Manganese	3.00	
Zinc	2.86	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36389
DATE: 09/30/92 crp

WATER ANALYSIS

Belt Wetland
Cell II Effluent, BWW2E30
Sampled 09/03/92 @ 1100
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	7830	
Total Acidity as $CaCO_3$	3390	
Calcium	471	
Magnesium	261	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	5760	µmhos/cm
pH	2.5	s.u.
Dissolved Metals		
Aluminum	338	
Iron	332	
Ferrous Iron	44.0	
Ferric Iron	288	
Manganese	10.7	
Zinc	2.21	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36390
DATE: 09/30/92 crp

WATER ANALYSIS

Belt Wetland
Cell III Effluent, BWW3E30
Sampled 09/03/92 @ 1100
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	5330	
Total Acidity as $CaCO_3$	0	
Calcium	679	
Magnesium	328	
Total Alkalinity as $CaCO_3$	282	
Specific Conductance @ 25°C	4890	µmhos/cm
pH	6.5	s.u.
Dissolved Metals		
Aluminum	1.9	
Iron	9.53	
Ferrous Iron	1.3	
Ferric Iron	8.2	
Manganese	18.4	
Zinc	0.99	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36390 dup
DATE: 09/30/92 crp

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Belt Wetland
Cell III Effluent, BWW3E30
Sampled 09/03/92 @ 1100
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	5310	
Total Acidity as $CaCO_3$	0	
Calcium	702	
Magnesium	355	
Total Alkalinity as $CaCO_3$	281	
Specific Conductance @ 25°C	4940	µmhos/cm
pH	6.6	s.u.
Dissolved Metals		
Aluminum	1.7	
Iron	9.45	
Ferrous Iron	1.3	
Ferric Iron	8.2	
Manganese	18.4	
Zinc	1.01	

LABORATORIES 1625 11TH AVE

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
	BELT WETLAND

SAMPLERS: (Signature) EARL McCurley Earl McCurley

STAT. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	REMARKS
CELL I	9/3/92	11:00	AM	✓	CELL I INFLUENT BWW1I30	3	PH, SC, Acidity, ALKALINITY
					HCL		TDS, MN, Mg, AL, Fe CA
					HNO_3		ZN, Ferric & Ferrous Iron
					NONE		
CELL I Effluent	9/3/92	11:00	AM	✓	CELL I Effluent BWW1E30	3	
					Hcl		
					HNO_3		
					None		
Cell II Effluent	9/3/92	11:00	AM		Cell II Effluent BWW2E30	3	
					Hcl		
					HNO_3		
					None		
Cell III Effluent	9/3/92	11:00	AM		Cell III Effluent BWW3E30	3	

Relinquished (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Earl McCurley					
Relinquished (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished (Signature)	Date/Time	Received for Laboratory by: (Signature) Sandra Hoelscher	Date/Time 09/04/92 1025	Remarks	

Split Samples:
[] Accepted [] Declined
Signature

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39229
DATE: 10/15/92 crp

RECEIVED
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STATE LANDS

WATER ANALYSIS

Belt Wetland, French Coulee
Cell I Influent, BWWI1-10-2
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	5460	µmhos/cm
Total Acidity as $CaCO_3$	5580	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	9080	
Magnesium	125	
Calcium	267	
Sulfate	5460	
Nitrate plus Nitrite as N	0.41	
Ferrous Iron	752	
Ferric Iron	298	
Dissolved Metals		
Aluminum	518	
Iron	1050	
Manganese	1.09	
Zinc	5.31	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39230
DATE: 10/15/92 crp

WATER ANALYSIS

Belt Wetland, French Coulee
Cell I Effluent, BWWE1-10-2
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	5510	µmhos/cm
Total Acidity as $CaCO_3$	5170	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	8840	
Magnesium	151	
Calcium	373	
Sulfate	5460	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	454	
Ferric Iron	406	
Dissolved Metals		
Aluminum	480	
Iron	860	
Manganese	2.28	
Zinc	3.46	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39230 dup
DATE: 10/15/92 crp

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Belt Wetland, French Coulee
Cell I Effluent, BWWE1-10-2
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.5	s.u.
Specific Conductance @ 25°C	5500	µmhos/cm
Total Acidity as $CaCO_3$	5230	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	8750	
Magnesium	151	
Calcium	372	
Sulfate	5490	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	454	
Ferric Iron	414	
Dissolved Metals		
Aluminum	482	
Iron	868	
Manganese	2.29	
Zinc	3.58	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39231
DATE: 10/15/92 crp

WATER ANALYSIS

Belt Wetland, French Coulee
Cell II Effluent, BWW2E-10-2
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.5	s.u.
Specific Conductance @ 25°C	5640	µmhos/cm
Total Acidity as $CaCO_3$	3470	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	7740	
Magnesium	261	
Calcium	513	
Sulfate	5130	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	33.7	
Ferric Iron	444	
Dissolved Metals		
Aluminum	328	
Iron	478	
Manganese	10.9	
Zinc	1.99	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39231 spi
DATE: 10/15/92 crp

QUALITY ASSURANCE - SPIKED ANALYSIS

Belt Wetland, French Coulee
Cell II Effluent, BWW2E-10-2
Sampled 10/02/92
Submitted 10/05/92

Constituent	% Recovery	
pH	N/A	s.u.
Specific Conductance @ 25°C	N/A	µmhos/cm
Total Acidity as $CaCO_3$	N/A	
Total Alkalinity as $CaCO_3$	N/A	
Total Dissolved Solids @ 180°C	N/A	
Magnesium	103	
Calcium	101	
Sulfate	99	
Nitrate plus Nitrite as N	104	
Ferrous Iron	90	
Ferric Iron	N/A	
Dissolved Metals		
Aluminum	98	
Iron	98	
Manganese	105	
Zinc	106	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39232
DATE: 10/15/92 crp

WATER ANALYSIS

Belt Wetland, French Coulee
Cell III Effluent, BWW3E-10-2
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	5640	µmhos/cm
Total Acidity as $CaCO_3$	3060	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	7360	
Magnesium	278	
Calcium	537	
Sulfate	4970	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	23.5	
Ferric Iron	378	
Dissolved Metals		
Aluminum	291	
Iron	402	
Manganese	13.3	
Zinc	2.00	

ENERGY LABORATORIES

Helena, MT 59620

444-2074

CHAIN OF CUSTODY RECORD

PROJ. NO.

PROJECT NAME: STOCKETT NE WETLAND — North + South Wetlands

SAMPLERS: (Signature) EARL McCurley Earl McCurley

STAT. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	REMARKS
SWWSI 10-1LMS	10/2			✓	S. WETLAND INFLUENT SWWSI-10-1LMS	3	SOUTH WETLAND INFLUENT THROUGH LIMESTONE TRENCH.
↕	↕				NONE, HCL, HNO3	↕	
SWWSI 10-1	10/2			✓	S. WETLAND INFLUENT SWWSI-10-1	3	ALL SAMPLES RUN for :
↕	↕				None, HCL, HNO3	2↕	
SWWSE-10-1	10/2			✓	S. WETLAND effluent SWWSE-10-1	3	Ph, Sc, ACIDITY, ALKALINITY
↕	↕				None, HCL, HNO3	↕	TDS, MN, Mg, AL, FE, CA
SWWNI 10-1LMS	10/2			✓	N. WETLAND INFLUENT SWWNI-10-1LMS	3	ZN, Ferric + Ferrous Iron
↕	↕				None, HCL, HNO3	↕	Sulfate Nitrate 3
SWWNI 10-1	10/2			✓	N. WETLAND INFLUENT SWWNI-10-1	3	
↕	↕				None, HCL, HNO3	↕	Samples taken between 11:00-2:30 PM 10-2-92
SWWNE-10-1	10/2			✓	N. WETLAND effluent SWWNE-10-1	3	
↕	↕				None, HCL, HNO3	↕	
SWWOE 10-1	10/2			✓	Combined WETLAND OUTFLOW effluent SWWOE-10-1	3	
↕	↕				None, HCL, HNO3	↕	

Relinquished (Signature)	Date/Time	Received by: (Signature)	Relinguished by: (Signature)	Date/Time	Received by: (Signature)
Earl McCurley	10-2-92 4:00PM				
Relinquished (Signature)	Date/Time	Received by: (Signature)	Relinguished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
		Kim Stellmon	10/05/92 1005		

Split Samples:
[] Accepted [] Declined

Signature

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45472
DATE: 11/17/92 da

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WATER ANALYSIS

Belt Wetland
BWW11-11-2
Cell I Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	235	
Magnesium	117	
Sulfate	5640	
Total Dissolved Solids @ 180° C	8830	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	5270	
Specific Conductance @ 25° C	5490	µmhos/cm
pH	2.8	s.u.
Nitrate plus Nitrite as N	0.12	

Total Metals

Aluminum	505	
Iron	1050	
Ferrous Iron	794	
Ferric Iron	256	
Manganese	0.99	
Zinc	5.17	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45473
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW1E-11-2
Cell I Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	297	
Magnesium	130	
Sulfate	5400	
Total Dissolved Solids @ 180° C	8230	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	4930	
Specific Conductance @ 25° C	5240	µmhos/cm
pH	2.8	s.u.
Nitrate plus Nitrite as N	0.08	

Total Metals

Aluminum	474	
Iron	917	
Ferrous Iron	581	
Ferric Iron	336	
Manganese	1.74	
Zinc	3.75	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45474
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW2E-11-2
Cell II Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	366	
Magnesium	172	
Sulfate	5070	
Total Dissolved Solids @ 180° C	7530	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	3880	
Specific Conductance @ 25° C	4850	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.08	

Total Metals

Aluminum	370	
Iron	605	
Ferrous Iron	70.2	
Ferric Iron	535	
Manganese	5.87	
Zinc	2.67	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45475
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW3I-11-2
Cell 3 Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	387	
Magnesium	173	
Sulfate	5050	
Total Dissolved Solids @ 180° C	7500	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	3930	
Specific Conductance @ 25° C	4860	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.08	

Total Metals

Aluminum	372	
Iron	602	
Ferrous Iron	65.6	
Ferric Iron	536	
Manganese	5.94	
Zinc	2.59	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45476
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW3E-11-2
Cell 3 Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	414	
Magnesium	201	
Sulfate	4750	
Total Dissolved Solids @ 180° C	6960	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	3360	
Specific Conductance @ 25° C	4860	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.09	

Total Metals

Aluminum	328	
Iron	508	
Ferrous Iron	39.2	
Ferric Iron	469	
Manganese	8.25	
Zinc	2.41	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45477
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
Natural Wetland Discharge
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	85	
Magnesium	49	
Sulfate	342	
Total Dissolved Solids @ 180° C	594	
Total Alkalinity as $CaCO_3$	109	
Total Acidity as $CaCO_3$	0	
Specific Conductance @ 25° C	813	µmhos/cm
pH	7.1	s.u.
Nitrate plus Nitrite as N	4.45	

Total Metals

Aluminum	23.0	
Iron	46.3	
Ferrous Iron	1.2	
Ferric Iron	45.1	
Manganese	0.51	
Zinc	0.12	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45472
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW1I-11-2
Cell I Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	235	
Magnesium	117	
Sulfate	5640	
Total Dissolved Solids @ 180° C	8830	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	5270	
Specific Conductance @ 25° C	5490	µmhos/cm
pH	2.8	s.u.
Nitrate plus Nitrite as N	0.12	

Total Metals

Aluminum	505	
Iron	1050	
Ferrous Iron	794	
Ferric Iron	256	
Manganese	0.99	
Zinc	5.17	

ENERGY LABORATORIES, INC.
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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45473
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW1E-11-2
Cell I Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	297	
Magnesium	130	
Sulfate	5400	
Total Dissolved Solids @ 180° C	8230	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	4930	
Specific Conductance @ 25° C	5240	µmhos/cm
pH	2.8	s.u.
Nitrate plus Nitrite as N	0.08	

Total Metals

Aluminum	474	
Iron	917	
Ferrous Iron	581	
Ferric Iron	336	
Manganese	1.74	
Zinc	3.75	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45474
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW2E-11-2
Cell II Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	366	
Magnesium	172	
Sulfate	5070	
Total Dissolved Solids @ 180° C	7530	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	3880	
Specific Conductance @ 25° C	4850	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.08	

Total Metals

Aluminum	370	
Iron	605	
Ferrous Iron	70.2	
Ferric Iron	535	
Manganese	5.87	
Zinc	2.67	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45475
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW3I-11-2
Cell 3 Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	387	
Magnesium	173	
Sulfate	5050	
Total Dissolved Solids @ 180° C	7500	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	3930	
Specific Conductance @ 25° C	4860	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.08	

Total Metals

Aluminum	372	
Iron	602	
Ferrous Iron	65.6	
Ferric Iron	536	
Manganese	5.94	
Zinc	2.59	

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45476
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
BWW3E-11-2
Cell 3 Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	414	
Magnesium	201	
Sulfate	4750	
Total Dissolved Solids @ 180° C	6960	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	3360	
Specific Conductance @ 25° C	4860	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.09	

Total Metals

Aluminum	328	
Iron	508	
Ferrous Iron	39.2	
Ferric Iron	469	
Manganese	8.25	
Zinc	2.41	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45477
DATE: 11/17/92 da

WATER ANALYSIS

Belt Wetland
Natural Wetland Discharge
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	85	
Magnesium	49	
Sulfate	342	
Total Dissolved Solids @ 180° C	594	
Total Alkalinity as $CaCO_3$	109	
Total Acidity as $CaCO_3$	0	
Specific Conductance @ 25° C	813	µmhos/cm
pH	7.1	s.u.
Nitrate plus Nitrite as N	4.45	

Total Metals

Aluminum	23.0
Iron	46.3
Ferrous Iron	1.2
Ferric Iron	45.1
Manganese	0.51
Zinc	0.12

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12950
DATE: 04/16/93 da

WATER ANALYSIS

Belt Wetlands/French Coulee
Cell I Influent
BWW11-4.5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	361	04/13/93
Magnesium	124	04/13/93
Sulfate	4990	04/12/93
Total Dissolved Solids @ 180° C	7250	04/07/93
Total Alkalinity as $CaCO_3$	0	04/07/93
Total Acidity as $CaCO_3$	3860	04/08/93
Specific Conductance @ 25°C	5240 µmhos/cm	04/07/93
pH	2.5 s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05	04/09/93
Total Metals		
Iron	500	04/06/93
Ferric Iron	348	04/07/93
Ferrous Iron	152	04/07/93
Manganese	1.26	04/08/93
Zinc	5.11	04/08/93

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12950 dup
DATE: 04/16/93 da

QUALITY ASSURANCE-DUPLICATE ANALYSIS

Belt Wetlands/French Coulee
Cell I Influent
BWW1I-4.5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	359	04/13/93
Magnesium	123	04/13/93
Sulfate	5000	04/12/93
Total Dissolved Solids @ 180° C	7240	04/07/93
Total Alkalinity as $CaCO_3$	0	04/07/93
Total Acidity as $CaCO_3$	3890	04/08/93
Specific Conductance @ 25°C	5240 µmhos/cm	04/07/93
pH	2.4 s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05	04/09/93
Total Metals		
Iron	499	04/06/93
Ferric Iron	349	04/07/93
Ferrous Iron	150	04/07/93
Manganese	1.25	04/08/93
Zinc	5.10	04/08/93

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12951
DATE: 04/16/93 da

WATER ANALYSIS

Belt Wetlands/French Coulee
Cell I Effluent
BWW1E-4.5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	437	04/13/93
Magnesium	142	04/13/93
Sulfate	5430	04/12/93
Total Dissolved Solids @ 180° C	7990	04/07/93
Total Alkalinity as $CaCO_3$	0	04/07/93
Total Acidity as $CaCO_3$	3940	04/08/93
Specific Conductance @ 25°C	5290 µmhos/cm	04/07/93
pH	3.4 s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05	04/09/93
Total Metals		
Iron	828	04/06/93
Ferric Iron	87.0	04/07/93
Ferrous Iron	741	04/07/93
Manganese	2.71	04/08/93
Zinc	3.62	04/08/93

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12951 spi
DATE: 04/16/93 da

QUALITY ASSURANCE-SPIKED ANALYSIS

Belt Wetlands/French Coulee
Cell I Effluent
BWW1E-4.5
Sampled 04/05/93
Submitted 04/06/93

Constituent	% Recovery		Date Analyzed
Calcium	103		04/13/93
Magnesium	104		04/13/93
Sulfate	99		04/12/93
Total Dissolved Solids @ 180° C	N/A		N/A
Total Alkalinity as $CaCO_3$	N/A		N/A
Total Acidity as $CaCO_3$	N/A		N/A
Specific Conductance @ 25°C	N/A	µmhos/cm	N/A
pH	N/A	s.u.	N/A
Nitrate plus Nitrite as N	105		04/09/93
Total Metals			
Iron	99		04/06/93
Ferric Iron	N/A		N/A
Ferrous Iron	90		04/07/93
Manganese	92		04/08/93
Zinc	98		04/08/93

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12952
DATE: 04/16/93 da

WATER ANALYSIS

Belt Wetlands/French Coulee
Cell II Effluent
BWW2E-4.5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	259	04/13/93
Magnesium	56	04/13/93
Sulfate	1890	04/08/93
Total Dissolved Solids @ 180° C	2650	04/07/93
Total Alkalinity as $CaCO_3$	0	04/07/93
Total Acidity as $CaCO_3$	1140	04/08/93
Specific Conductance @ 25°C	2660 µmhos/cm	04/07/93
pH	2.8 s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05	04/09/93
Total Metals		
Iron	108	04/06/93
Ferric Iron	89.5	04/07/93
Ferrous Iron	18.5	04/07/93
Manganese	1.51	04/12/93
Zinc	0.90	04/12/93

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12953
DATE: 04/16/93 da

WATER ANALYSIS

Belt Wetlands/French Coulee
Cell III Effluent
BWW3E-4.5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	460	04/13/93
Magnesium	160	04/13/93
Sulfate	2300	04/08/93
Total Dissolved Solids @ 180° C	3420	04/07/93
Total Alkalinity as $CaCO_3$	0	04/07/93
Total Acidity as $CaCO_3$	395	04/08/93
Specific Conductance @ 25°C	3420 µmhos/cm	04/07/93
pH	3.5 s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05	04/09/93
Total Metals		
Iron	186	04/06/93
Ferric Iron	<0.1	04/07/93
Ferrous Iron	186	04/07/93
Manganese	9.29	04/12/93
Zinc	0.05	04/12/93

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LABORATORY REPORT

TO: MT Dept. of State Lands
ADDRESS: Abandoned Mines & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12954
DATE: 04/16/93 da

WATER ANALYSIS

Belt Wetlands/French Coulee
National Discharge
BWWND-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	58	04/13/93
Magnesium	35	04/13/93
Sulfate	57	04/12/93
Total Dissolved Solids @ 180° C	285	04/07/93
Total Alkalinity as $CaCO_3$	212	04/07/93
Total Acidity as $CaCO_3$	0	04/08/93
Specific Conductance @ 25°C	528 µmhos/cm	04/07/93
pH	8.3 s.u.	04/07/93
Nitrate plus Nitrite as N	3.70	04/09/93
Total Metals		
Iron	0.53	04/06/93
Ferric Iron	0.3	04/07/93
Ferrous Iron	0.2	04/07/93
Manganese	0.02	04/08/93
Zinc	<0.01	04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18009
DATE: 05/21/93 crp

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WATER ANALYSIS

Bect/Stockett, BWWIT-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	162		05/11/93
Magnesium	84		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	2260		05/11/93
Specific Conductance @ 25°C	3540	µmhos/cm	05/10/93
pH	2.6	s.u.	05/10/93
Sulfate	2850		05/14/93
Nitrate plus Nitrite as N	0.20		05/10/93
Total Dissolved Solids @ 180°C	4280		05/11/93
Total Metals			
Aluminum	224		05/17/93
Iron	454		05/07/93
Ferric Iron	263		05/07/93
Ferrous Iron	191		05/07/93
Manganese	0.34		05/11/93
Zinc	2.13		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18010
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, BWWIE-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	228		05/11/93
Magnesium	88		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	2110		05/11/93
Specific Conductance @ 25°C	3670	µmhos/cm	05/10/93
pH	2.5	s.u.	05/10/93
Sulfate	3070		05/14/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	4230		05/11/93
Total Metals			
Aluminum	216		05/17/93
Iron	398		05/07/93
Ferric Iron	222		05/07/93
Ferrous Iron	176		05/07/93
Manganese	0.57		05/11/93
Zinc	1.79		05/11/93

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18010 dup
DATE: 05/21/93 crp

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Bect/Stockett, BWWIE-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	225		05/11/93
Magnesium	87		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	2120		05/11/93
Specific Conductance @ 25°C	3670	µmhos/cm	05/10/93
pH	2.5	s.u.	05/10/93
Sulfate	3010		05/14/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	4230		05/11/93
Total Metals			
Aluminum	220		05/17/93
Iron	397		05/07/93
Ferric Iron	234		05/07/93
Ferrous Iron	163		05/07/93
Manganese	0.58		05/11/93
Zinc	1.82		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18011
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, BWW2E-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	260		05/11/93
Magnesium	93		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	2090		05/11/93
Specific Conductance @ 25°C	3730	µmhos/cm	05/10/93
pH	2.5	s.u.	05/10/93
Sulfate	3030		05/14/93
Nitrate plus Nitrite as N	<0.05		05/12/93
Total Dissolved Solids @ 180°C	4300		05/11/93
Total Metals			
Aluminum	256		05/17/93
Iron	310		05/07/93
Ferric Iron	303		05/07/93
Ferrous Iron	6.6		05/07/93
Manganese	1.07		05/11/93
Zinc	1.84		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18011 spi
DATE: 05/21/93 crp

QUALITY ASSURANCE - SPIKED ANALYSIS

Bect/Stockett, BWW2E-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	% Recovery		Date Analyzed
Calcium	103		05/11/93
Magnesium	102		05/11/93
Total Alkalinity as $CaCO_3$	N/A		N/A
Total Acidity as $CaCO_3$	N/A		N/A
Specific Conductance @ 25°C	N/A	µmhos/cm	N/A
pH	N/A	s.u.	N/A
Sulfate	98		05/14/93
Nitrate plus Nitrite as N	102		05/12/93
Total Dissolved Solids @ 180°C	N/A		N/A
Total Metals			
Aluminum	101		05/07/93
Iron	100		05/07/93
Ferric Iron	N/A		N/A
Ferrous Iron	91		05/07/93
Manganese	98		05/11/93
Zinc	98		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18012
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, BWW3E-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	339		05/11/93
Magnesium	110		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	1960		05/11/93
Specific Conductance @ 25°C	3930	µmhos/cm	05/10/93
pH	2.6	s.u.	05/10/93
Sulfate	3300		05/14/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	4440		05/11/93
Total Metals			
Aluminum	248		05/17/93
Iron	255		05/07/93
Ferric Iron	247		05/07/93
Ferrous Iron	8.4		05/07/93
Manganese	2.61		05/11/93
Zinc	1.80		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18013
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, BWWND-5-6
Sampled 05/06/93 @ 1200
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	64		05/11/93
Magnesium	37		05/11/93
Total Alkalinity as $CaCO_3$	230		05/10/93
Total Acidity as $CaCO_3$	0		05/11/93
Specific Conductance @ 25°C	546	µmhos/cm	05/10/93
pH	8.3	s.u.	05/10/93
Sulfate	53		05/14/93
Nitrate plus Nitrite as N	4.56		05/10/93
Total Dissolved Solids @ 180°C	325		05/11/93
Total Metals			
Aluminum	0.1		05/17/93
Iron	0.16		05/07/93
Ferric Iron	0.2		05/07/93
Ferrous Iron	<0.1		05/07/93
Manganese	<0.01		05/11/93
Zinc	0.03		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22402
DATE: 06/23/93 da

WATER ANALYSIS

Belt Wetland
BWW1I-6-7
Cell I Influent
Sampled 06/07/93 @ 1630
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	182		06/10/93
Magnesium	90		06/10/93
Sulfate	3270		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	5290		06/09/93
Specific Conductance @ 25°C	3860	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	2700		06/09/93
Nitrate plus Nitrite as N	0.23		06/16/93
Total Metals			
Aluminum	222		06/11/93
Iron	582		06/10/93
Ferrous Iron	200		06/11/93
Ferric Iron	382		06/11/93
Manganese	0.54		06/10/93
Zinc	2.95		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22403
DATE: 06/23/93 da

WATER ANALYSIS

Belt Wetland
BWW1E-6-7
Cell I Effluent
Sampled 06/07/93 @ 1630
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	291		06/10/93
Magnesium	94		06/10/93
Sulfate	3340		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	5310		06/09/93
Specific Conductance @ 25°C	3910	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	2450		06/09/93
Nitrate plus Nitrite as N	<0.05		06/16/93
Total Metals			
Aluminum	219		06/11/93
Iron	464		06/10/93
Ferrous Iron	210		06/11/93
Ferric Iron	254		06/11/93
Manganese	0.92		06/10/93
Zinc	1.89		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22404
DATE: 06/23/93 da

WATER ANALYSIS

Belt Wetland
BWW2E-6-7
Cell 2 Effluent
Sampled 06/07/93 @ 1630
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	685		06/10/93
Magnesium	149		06/10/93
Sulfate	3060		06/18/93
Total Alkalinity as $CaCO_3$	74		06/09/93
Total Dissolved Solids @ 180°C	5060		06/09/93
Specific Conductance @ 25°C	4310	µmhos/cm	06/09/93
pH	5.9	s.u.	06/09/93
Total Acidity as $CaCO_3$	644		06/09/93
Nitrate plus Nitrite as N	<0.05		06/16/93
Total Metals			
Aluminum	30.5		06/11/93
Iron	499		06/10/93
Ferrous Iron	308		06/11/93
Ferric Iron	191		06/11/93
Manganese	7.36		06/10/93
Zinc	0.05		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22405
DATE: 06/23/93 da

WATER ANALYSIS

Belt Wetland
BWW3E-6-7
Cell 3 Effluent
Sampled 06/07/93 @ 1630
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	641		06/10/93
Magnesium	155		06/10/93
Sulfate	2970		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	4610		06/09/93
Specific Conductance @ 25°C	4330	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	989		06/09/93
Nitrate plus Nitrite as N	<0.05		06/16/93
Total Metals			
Aluminum	13.4		06/11/93
Iron	217		06/10/93
Ferrous Iron	47.9		06/11/93
Ferric Iron	169		06/11/93
Manganese	7.63		06/10/93
Zinc	0.12		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22406
DATE: 06/23/93 da

WATER ANALYSIS

Belt Wetland
BWWND-6-7
Natural Discharge
Sampled 06/07/93 @ 1630
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	65		06/10/93
Magnesium	37		06/10/93
Sulfate	47		06/18/93
Total Alkalinity as $CaCO_3$	248		06/09/93
Total Dissolved Solids @ 180°C	378		06/09/93
Specific Conductance @ 25°C	607	µmhos/cm	06/09/93
pH	8.3	s.u.	06/09/93
Total Acidity as $CaCO_3$	0		06/09/93
Nitrate plus Nitrite as N	8.16		06/16/93
Total Metals			
Aluminum	<0.1		06/11/93
Iron	0.11		06/10/93
Ferrous Iron	<0.1		06/11/93
Ferric Iron	0.1		06/11/93
Manganese	<0.01		06/10/93
Zinc	0.01		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-27996
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Belt Wetland, Cell 1 Influent, BWW1I-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	164		07/13/93
Magnesium	83		07/13/93
Sulfate	2540		07/13/93
Total Dissolved Solids @ 180°C	4200		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3360	µmhos/cm	07/12/93
pH	2.8	s.u.	07/12/93
Total Acidity as $CaCO_3$	1870		07/12/93
Nitrate plus Nitrite as N	0.67		07/14/93
Total Metals			
Aluminum	192		07/13/93
Iron	362		07/12/93
Ferrous Iron	221		07/13/93
Ferric Iron	141		07/13/93
Manganese	0.39		07/13/93
Zinc	2.48		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-27997
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Belt Wetland, Cell 1 Effluent, BWW1E-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	238		07/13/93
Magnesium	85		07/13/93
Sulfate	2940		07/13/93
Total Dissolved Solids @ 180°C	4900		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3710	µmhos/cm	07/12/93
pH	2.7	s.u.	07/12/93
Total Acidity as $CaCO_3$	2090		07/12/93
Nitrate plus Nitrite as N	0.14		07/14/93
Total Metals			
Aluminum	227		07/13/93
Iron	373		07/12/93
Ferrous Iron	91.7		07/13/93
Ferric Iron	281		07/13/93
Manganese	0.81		07/13/93
Zinc	2.11		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-27998
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Belt Wetland, Cell 2 Effluent, BWW2E-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	251		07/13/93
Magnesium	82		07/13/93
Sulfate	2850		07/13/93
Total Dissolved Solids @ 180°C	4730		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3560	µmhos/cm	07/12/93
pH	2.7	s.u.	07/12/93
Total Acidity as $CaCO_3$	2120		07/12/93
Nitrate plus Nitrite as N	<0.05		07/14/93
Total Metals			
Aluminum	191		07/13/93
Iron	311		07/12/93
Ferrous Iron	67.5		07/13/93
Ferric Iron	244		07/13/93
Manganese	1.83		07/13/93
Zinc	1.63		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-27999
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Belt Wetland, Cell 3 Effluent, BWW3E-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	300		07/13/93
Magnesium	82		07/13/93
Sulfate	2400		07/13/93
Total Dissolved Solids @ 180°C	3920		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3400	µmhos/cm	07/12/93
pH	2.8	s.u.	07/12/93
Total Acidity as $CaCO_3$	1340		07/12/93
Nitrate plus Nitrite as N	0.06		07/14/93
Total Metals			
Aluminum	142		07/13/93
Iron	208		07/12/93
Ferrous Iron	31.7		07/13/93
Ferric Iron	176		07/13/93
Manganese	2.35		07/13/93
Zinc	1.12		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28000
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Belt Wetland, Natural Discharge, BWWND-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	76		07/13/93
Magnesium	31		07/13/93
Sulfate	103		07/13/93
Total Dissolved Solids @ 180°C	400		07/12/93
Total Alkalinity as $CaCO_3$	201		07/12/93
Specific Conductance @ 25°C	632	µmhos/cm	07/12/93
pH	7.3	s.u.	07/12/93
Total Acidity as $CaCO_3$	<1		07/12/93
Nitrate plus Nitrite as N	7.39		07/14/93
Total Metals			
Aluminum	3.1		07/13/93
Iron	3.30		07/12/93
Ferrous Iron	0.4		07/13/93
Ferric Iron	2.9		07/13/93
Manganese	0.08		07/13/93
Zinc	0.03		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28000 dup
DATE: 07/20/93 dlf

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Wetland Water Samples
Belt Wetland, Natural Discharge, BWWND-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	76		07/13/93
Magnesium	31		07/13/93
Sulfate	102		07/13/93
Total Dissolved Solids @ 180°C	405		07/12/93
Total Alkalinity as $CaCO_3$	197		07/12/93
Specific Conductance @ 25°C	632	µmhos/cm	07/12/93
pH	7.4	s.u.	07/12/93
Total Acidity as $CaCO_3$	<1		07/12/93
Nitrate plus Nitrite as N	7.13		07/14/93
Total Metals			
Aluminum	3.1		07/13/93
Iron	3.31		07/12/93
Ferrous Iron	0.4		07/13/93
Ferric Iron	2.9		07/13/93
Manganese	0.08		07/13/93
Zinc	0.03		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28001
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Centerville, Cell 1 Influent, CWW1I-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	229		07/13/93
Magnesium	95		07/13/93
Sulfate	3150		07/13/93
Total Dissolved Solids @ 180°C	5020		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3750	µmhos/cm	07/12/93
pH	2.7	s.u.	07/12/93
Total Acidity as $CaCO_3$	2220		07/12/93
Nitrate plus Nitrite as N	0.57		07/14/93
Total Metals			
Aluminum	263		07/13/93
Iron	58.0		07/12/93
Ferrous Iron	0.8		07/13/93
Ferric Iron	57.2		07/13/93
Manganese	2.54		07/13/93
Zinc	2.84		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28002
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Centerville, Cell 1 Effluent, CWW1E-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	257		07/13/93
Magnesium	85		07/13/93
Sulfate	2650		07/13/93
Total Dissolved Solids @ 180°C	4260		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3340	µmhos/cm	07/12/93
pH	2.9	s.u.	07/12/93
Total Acidity as $CaCO_3$	1730		07/12/93
Nitrate plus Nitrite as N	<0.05		07/14/93
Total Metals			
Aluminum	206		07/13/93
Iron	180		07/12/93
Ferrous Iron	80.3		07/13/93
Ferric Iron	99.7		07/13/93
Manganese	2.12		07/13/93
Zinc	2.38		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28003
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Centerville, Cell 2 Effluent, CWW2E-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	547		07/13/93
Magnesium	128		07/13/93
Sulfate	2290		07/13/93
Total Dissolved Solids @ 180°C	3470		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3400	µmhos/cm	07/12/93
pH	4.2	s.u.	07/12/93
Total Acidity as $CaCO_3$	245		07/19/93
Nitrate plus Nitrite as N	<0.05		07/14/93
Total Metals			
Aluminum	39.6		07/13/93
Iron	2.40		07/12/93
Ferrous Iron	2.1		07/13/93
Ferric Iron	0.3		07/13/93
Manganese	4.51		07/13/93
Zinc	0.25		07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28004
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Centerville, Cell 3 Effluent, CWW3E-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	542		07/13/93
Magnesium	124		07/13/93
Sulfate	2150		07/13/93
Total Dissolved Solids @ 180°C	3280		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	3270	µmhos/cm	07/12/93
pH	4.4	s.u.	07/12/93
Total Acidity as $CaCO_3$	158		07/12/93
Nitrate plus Nitrite as N	<0.05		07/14/93
Total Metals			
Aluminum	18.7		07/13/93
Iron	4.73		07/12/93
Ferrous Iron	4.6		07/13/93
Ferric Iron	0.1		07/13/93
Manganese	4.55		07/13/93
Zinc	0.18		07/13/93

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STATE LANDS

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28001 spi
DATE: 07/20/93 dlf

QUALITY ASSURANCE - SPIKED ANALYSIS

Wetland Water Samples
Centerville, Cell 1 Influent, CWW1I-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	% Recovery	Date Analyzed
Calcium	100	07/13/93
Magnesium	98	07/13/93
Sulfate	102	07/13/93
Total Dissolved Solids @ 180 C	N/A	N/A
Total Alkalinity as $CaCO_3$	N/A	N/A
Specific Conductance @ 25°C	N/A	N/A
pH	N/A	N/A
Total Acidity as $CaCO_3$	N/A	N/A
Nitrate plus Nitrite as N	89	07/14/93
Total Metals		
Aluminum	100	07/13/93
Iron	111	07/12/93
Ferrous Iron	91	07/13/93
Ferric Iron	N/A	N/A
Manganese	103	07/13/93
Zinc	101	07/13/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28005
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Stockett, Total Outflow, SWWTO-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	435		07/13/93
Magnesium	258		07/13/93
Sulfate	9190		07/13/93
Total Dissolved Solids @ 180°C	13800		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	7590	µmhos/cm	07/12/93
pH	2.7	s.u.	07/12/93
Total Acidity as $CaCO_3$	7270		07/12/93
Nitrate plus Nitrite as N	1.29		07/14/93
Total Metals			
Aluminum	1050		07/13/93
Iron	937		07/12/93
Ferrous Iron	488		07/13/93
Ferric Iron	449		07/13/93
Manganese	10.6		07/13/93
Zinc	65.5		07/13/93

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Tom Hudson
Schafer & Associates
P.O. Box 6186
Bozeman, MT 59715

WATER ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93-51907
Sample Identification	FC-1(A,H,C,B)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	mg/l (ppm)	Date Analyzed
Calcium	178	11/01/93
Magnesium	91	11/01/93
Sulfate	3680	11/02/93
Total Dissolved Solids @ 180°C	5320	11/02/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	3180	10/29/93
Nitrate plus Nitrite as N	0.46	11/03/93
Ferric Iron	231	10/27/93
Ferrous Iron	324	10/27/93
Metals		
Aluminum, Total Recoverable	305	10/28/93
Aluminum, Dissolved	290	10/28/93
Iron, Total Recoverable	555	10/26/93
Iron, Dissolved	555	10/26/93
Manganese, Total Recoverable	0.56	10/28/93
Manganese, Dissolved	0.47	10/28/93
Zinc, Total Recoverable	3.72	10/28/93
Zinc, Dissolved	2.70	10/28/93

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Tom Hudson
Schafer & Associates
P.O. Box 6186
Bozeman, MT 59715

WATER ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93-51908
Sample Identification	FC-2(A,H,C,B)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	mg/l (ppm)	Date Analyzed
Calcium	247	11/01/93
Magnesium	94	11/01/93
Sulfate	3700	11/02/93
Total Dissolved Solids @ 180°C	5600	11/07/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	3020	10/29/93
Nitrate plus Nitrite as N	0.11	11/03/93
Ferric Iron	197	10/27/93
Ferrous Iron	270	10/27/93
Metals		
Aluminum, Total Recoverable	309	10/28/93
Aluminum, Dissolved	309	10/28/93
Iron, Total Recoverable	467	10/26/93
Iron, Dissolved	467	10/26/93
Manganese, Total Recoverable	0.66	10/28/93
Manganese, Dissolved	0.66	10/28/93
Zinc, Total Recoverable	4.53	10/28/93
Zinc, Dissolved	4.53	10/28/93

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Tom Hudson
Schafer & Associates
P.O. Box 6186
Bozeman, MT 59715

WATER ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93-51909
Sample Identification	FC-3(A,H,C,B)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	mg/l (ppm)	Date Analyzed
Calcium	547	11/01/93
Magnesium	134	11/01/93
Sulfate	3640	11/02/93
Total Dissolved Solids @ 180°C	5380	11/02/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	1930	10/29/93
Nitrate plus Nitrite as N	<0.05	11/03/93
Ferric Iron	118	10/27/93
Ferrous Iron	295	10/27/93
Metals		
Aluminum, Total Recoverable	209	10/28/93
Aluminum, Dissolved	185	10/28/93
Iron, Total Recoverable	413	10/26/93
Iron, Dissolved	413	10/26/93
Manganese, Total Recoverable	3.98	10/28/93
Manganese, Dissolved	3.64	10/28/93
Zinc, Total Recoverable	1.11	10/28/93
Zinc, Dissolved	0.98	10/28/93

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WATER ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93-51910
Sample Identification	FC-5(A,H,C,B)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	mg/l (ppm)	Date Analyzed
Calcium	547	11/01/93
Magnesium	141	11/01/93
Sulfate	3530	11/02/93
Total Dissolved Solids @ 180°C	5070	11/02/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	1840	10/29/93
Nitrate plus Nitrite as N	<0.05	11/03/93
Ferric Iron	118	10/27/93
Ferrous Iron	236	10/27/93
Metals		
Aluminum, Total Recoverable	182	10/28/93
Aluminum, Dissolved	173	10/28/93
Iron, Total Recoverable	354	10/26/93
Iron, Dissolved	354	10/26/93
Manganese, Total Recoverable	5.16	10/28/93
Manganese, Dissolved	4.91	10/28/93
Zinc, Total Recoverable	1.52	10/28/93
Zinc, Dissolved	1.48	10/28/93

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QUALITY ASSURANCE–DUPLICATE ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93–51910 dup
Sample Identification	FC–5(A,H,C,B)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	mg/l (ppm)	Date Analyzed
Calcium	547	11/01/93
Magnesium	141	11/01/93
Sulfate	3560	11/02/93
Total Dissolved Solids @ 180°C	5090	11/02/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	1850	10/29/93
Nitrate plus Nitrite as N	<0.05	11/03/93
Ferric Iron	120	10/27/93
Ferrous Iron	240	10/27/93
Metals		
Aluminum, Total Recoverable	182	10/28/93
Aluminum, Dissolved	174	10/28/93
Iron, Total Recoverable	360	10/26/93
Iron, Dissolved	360	10/26/93
Manganese, Total Recoverable	5.18	10/28/93
Manganese, Dissolved	4.95	10/28/93
Zinc, Total Recoverable	1.48	10/28/93
Zinc, Dissolved	1.41	10/28/93

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WATER ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93–51911
Sample Identification	FC–2 (F,D)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	mg/l (ppm)	Date Analyzed
Calcium	192	11/09/93
Magnesium	97	11/09/93
Sulfate	3610	11/02/93
Total Dissolved Solids @ 180°C	4940	11/02/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	3090	10/29/93
Nitrate plus Nitrite as N	0.15	11/03/93
Ferric Iron	386	10/27/93
Ferrous Iron	148	10/27/93
Total Recoverable Iron	534	10/26/93

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QUALITY ASSURANCE–SPIKED ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93–51911 spi
Sample Identification	FC–2 (F,D)
Sample Date	10/22/93
Submitted Date	10/26/93
Reported Date	11/12/93 da

Constituent	% Recovery	Date Analyzed
Calcium	102	11/09/93
Magnesium	99	11/09/93
Sulfate	100	11/02/93
Total Dissolved Solids @ 180°C	N/A	N/A
Total Alkalinity as CaCO3	N/A	N/A
Total Acidity as CaCO3	N/A	N/A
Nitrate plus Nitrite as N	96	11/03/93
Ferric Iron	N/A	N/A
Ferrous Iron	86	10/27/93
Total Recoverable Iron	103	10/26/93

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WATER ANALYSIS
French Coulee Wetland Treatment Site
Near Belt, MT

Lab No.	93-51912	
Sample Identification	FC-2 (G,E)	
Sample Date	10/22/93	
Submitted Date	10/26/93	
Reported Date	11/12/93 da	
Constituent	mg/l (ppm)	Date Analyzed
Calcium	293	11/02/93
Magnesium	98	11/02/93
Sulfate	3860	11/02/93
Total Dissolved Solids @ 180°C	5740	11/02/93
Total Alkalinity as CaCO3	<1	10/29/93
Total Acidity as CaCO3	3000	10/29/93
Nitrate plus Nitrite as N	0.13	11/03/93
Ferric Iron	96.0	10/27/93
Ferrous Iron	383	10/27/93
Total Recoverable Iron	479	10/26/93

TABLE A.1 FRENCH COULEE WETLAND DATA

Sample Date	Sample Location	Reading, Parshall (Inches)	Calc. Flow (gpm)	pH (su)	EC (mmhos/cm)	Temp. (Deg C)	TDS (mg/L)	SO4 (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	Fe (Total) (mg/L)	Fe (2+) (mg/L)	Fe (3+) (mg/L)	Mn (mg/L)	Zn (mg/L)	Al (mg/L)	Mg (mg/L)	Ca (mg/L)
07/02/91	FC-1	NA	NA	2.4	4.17	NA	5520	3550	3070	0	619.0	541.0	78.0	0.70	3.02	278.0	90	194
07/02/91	FC-2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/02/91	FC-3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/02/91	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/02/91	FC-5	NA	NA	NA	NA	NA	3450	470	0	1020	0.7	0.6	0.1	0.77	0.12	0.1	90	100
07/11/91	FC-1	NA	NA	2.8	4.62	10.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/11/91	FC-2	NA	NA	6.6	2.46	15.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/11/91	FC-3	NA	NA	5.8	4.32	15.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/11/91	FC-4	NA	NA	6.3	4.36	16.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/11/91	FC-5	NA	NA	6.5	4.76	16.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/17/91	FC-1	3.2	19.6	2.7	3.58	11.2	7070	4250	3690	0	680.0	583.0	97.0	0.59	2.53	334.0	104	161
07/17/91	FC-2	***5.2***	***41.5***	3.6	3.49	20.2	5860	3630	1980	0	384.0	333.0	51.0	4.14	1.89	180.0	135	353
07/17/91	FC-3	3.6	23.5	5.6	4.02	26.2	3570	2120	1150	0	0.2	0.2	0.0	5.22	0.33	0.2	125	406
07/17/91	FC-4	3.3	20.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/17/91	FC-5	NA	NA	7.8	4.76	28.6	3930	1730	0	447	0.3	0.3	0.0	2.83	0.00	0.0	137	343
08/07/91	FC-1	2.9	16.8	2.8	5.75	11.9	NA	5110	***6140***	0	763.0	501.0	262.0	0.83	4.38	395.0	116	260
08/07/91	FC-2	***4.2***	***29.8***	3.0	6.72	21.8	NA	4690	1980	0	479.0	449.0	30.0	6.33	3.26	244.0	161	567
08/07/91	FC-3	NA	NA	3.1	6.68	21.2	NA	3950	1760	0	105.0	100.0	5.0	7.16	1.77	104.0	182	666
08/07/91	FC-4	2.3	11.7	2.9	6.37	20.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
08/07/91	FC-5	NA	NA	7.1	6.30	18.8	NA	2580	0	408	0.6	0.6	0.0	4.53	0.00	0.4	203	666
08/22/91	FC-1	3 5	22.5	3.0	5.55	16.0	9316	5250	4564	0	952.0	481.0	471.0	0.90	4.40	465.0	112	238
08/22/91	FC-2	***5.5***	***45.3***	3.2	5.80	27.3	7468	4791	2827	0	636.0	492.0	144.0	6.60	2.70	276.0	176	533
08/22/91	FC-3	NA	NA	3.1	6.47	25.5	5484	3729	678	0	46.0	2.0	44.0	9.90	1.20	67.0	251	678
08/22/91	FC-4	2.0	9.4	3.4	6.30	24.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
08/22/91	FC-5	NA	NA	4.6	5.95	23.8	4864	3576	205	0	6.4	1.0	5.4	10.60	0.60	19.0	265	702
09/10/91	FC-1	***7.3***	***70.5***	2.5	6.62	11.6	***16016***	6612	5137	0	1093.0	445.0	648.0	1.00	4.80	518.0	NA	NA
09/10/91	FC-2	***8.4***	***87.3***	3.0	6.54	18.6	***4373***	5883	3430	0	804.0	388.0	416.0	6.20	2.70	315.0	NA	NA
09/10/91	FC-3	***7.8***	***77.8***	3.2	6.19	13.8	6847	4227	980	0	150.5	129.0	21.5	10.40	1.20	101.0	NA	NA
09/10/91	FC-4	***7.8***	***77.8***	3.1	6.18	13.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09/10/91	FC-5	***5.3***	***42.5***	7.1	6.70	13.2	6385	3282	0	0	0.1	0.1	0.0	4.00	0.10	1.0	NA	NA
10/17/91	FC-1	2.4	12.5	3.1	6.21	10.6	9576	6330	4848	0	1044.0	600.0	444.0	0.90	4.80	499.0	121	248
10/17/91	FC-2	***8.0***	***80.9***	3.2	6.03	8.9	8942	6465	3939	0	854.0	636.0	218.0	4.90	3.30	379.0	168	456
10/17/91	FC-3	NA	NA	3.3	6.35	7.3	7315	5256	2022	0	275.1	117.0	158.1	10.40	2.20	235.0	256	571
10/17/91	FC-4	1.4	5.4	3.3	6.41	7.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10/17/91	FC-5	NA	NA	4.1	6.32	6.7	6745	4632	929	0	91.8	82.0	9.8	15.30	1.00	110.0	318	676
11/13/91	FC-1	NA	NA	2.6	6.58	NA	NA	NA	NA	0	1051.0	836.0	215.0	0.90	4.90	507.0	118	257
11/13/91	FC-2	NA	NA	3.0	5.93	NA	NA	NA	NA	0	868.0	736.0	132.0	3.90	2.40	364.0	147	401
11/13/91	FC-3	NA	NA	3.3	4.68	NA	NA	NA	NA	0	427.0	380.0	47.0	6.80	1.10	142.0	152	394
11/13/91	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/13/91	FC-5	NA	NA	6.7	5.98	NA	NA	NA	NA	0	9.6	9.0	0.6	8.20	0.10	1.0	311	636
01/21/92	FC-1	NA	NA	2.5	6.35	8.7	9978	7008	4820	0	934.0	NA	NA	1.00	5.10	501.0	119	252
01/21/92	FC-2	NA	NA	2.9	5.59	3.3	9091	5994	3941	0	808.0	NA	NA	3.20	2.40	410.0	142	379
01/21/92	FC-3	NA	NA	3.0	5.18	1.2	8441	5535	3260	0	590.0	NA	NA	6.70	2.10	330.0	174	401
01/21/92	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01/21/92	FC-5	NA	NA	4.4	5.10	0.8	7662	4755	1883	0	607.0	NA	NA	10.40	1.20	156.0	250	583
09/03/92	FC-1	NA	NA	2.4	4.68	NA	8550	NA	4400	0	564.0	93.1	470.9	3.64	1.98	478.0	171	467
09/03/92	FC-2	NA	NA	2.4	5.38	NA	8250	NA	4400	0	660.0	279.0	381.0	3.00	2.86	451.0	152	408
09/03/92	FC-3	NA	NA	2.5	5.76	NA	7830	NA	3390	0	332.0	44.0	288.0	10.70	2.21	338.0	261	471
09/03/92	FC-4	NA	NA	6.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09/03/92	FC-5	NA	NA	NA	4.89	NA	5330	NA	0	282	9.5	1.3	8.2	18.40	0.99	1.9	328	679
09/03/92	BWWND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

FC-1 = No. 1 Flume; FC-2 = No. 2 Flume; FC-3 = No. 3 Flume; FC-4 = No. 4 Flume; FC-5 = No. 5 Flume;BWWND = Natural Drainage at Tracks

Bold,italic data are questionable values and were deleted for data analysis purposes.

TABLE A.1 FRENCH COULEE WETLAND DATA

Sample Date	Sample Location	Reading, Parshall (inches)	Calc. Flow (gpm)	pH (su)	EC (mmhos/cm)	Temp. (Deg C)	TDS (mg/L)	SO4 (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	Fe (Total) (mg/L)	Fe (2+) (mg/L)	Fe (3+) (mg/L)	Mn (mg/L)	Zn (mg/L)	Al (mg/L)	Mg (mg/L)	Ca (mg/L)
10/05/92	FC-1	NA	NA	2.6	5.46	NA	9080	5460	5580	0	1050.0	752.0	298.0	1.09	5.31	518.0	125	267
10/05/92	FC-2	NA	NA	2.6	5.51	NA	8840	5460	5170	0	860.0	454.0	406.0	2.28	3.46	480.0	151	373
10/05/92	FC-3	NA	NA	2.5	5.64	NA	7740	5130	3470	0	478.0	33.7	444.3	10.90	1.99	328.0	261	513
10/05/92	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10/05/92	FC-5	NA	NA	2.6	5.64	NA	7360	4970	3060	0	402.0	23.5	378.5	13.30	2.00	291.0	278	537
10/05/92	BWWND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/02/92	FC-1	NA	NA	2.8	5.49	11.5	8830	5640	5270	0	1050.0	794.0	256.0	0.99	5.17	505.0	117	235
11/02/92	FC-2	NA	NA	2.8	5.24	8.3	8230	5400	4930	0	917.0	581.0	336.0	1.74	3.75	474.0	130	297
11/02/92	FC-3	NA	NA	2.7	4.85	3.8	7530	5070	3880	0	605.0	70.2	534.8	5.87	2.67	370.0	172	366
11/02/92	FC-4	NA	NA	2.6	NA	3.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/02/92	FC-5	NA	NA	2.7	4.86	4.3	6960	4750	3360	0	508.0	39.2	468.8	8.25	2.41	328.0	201	414
11/02/92	BWWND	NA	NA	7.1	0.81	2.5	594	342	0	109	46.3	1.2	45.1	0.51	0.12	23.0	49	85
04/05/93	FC-1	3.0	17.7	2.5	5.24	NA	7250	4990	3860	0	500.0	348.0	152.0	1.26	5.11	NA	124	361
04/05/93	FC-2	NA	NA	3.4	5.29	NA	7990	5290	3940	0	828.0	87.0	741.0	2.71	3.61	NA	142	437
04/05/93	FC-3	NA	NA	2.8	2.66	NA	2650	1890	1140	0	108.0	89.5	18.5	1.51	0.90	NA	56	259
04/05/93	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/05/93	FC-5	NA	NA	3.5	3.42	NA	3420	2300	395	0	186.0	186.0	0.0	9.29	0.05	NA	160	460
04/05/93	BWWND	NA	NA	8.3	0.53	NA	285	57	0	212	0.5	0.2	0.3	0.02	0.01	NA	35	58
05/06/93	FC-1	3.6	23.5	2.6	3.54	NA	4280	2850	2260	0	454.0	191.0	263.0	0.34	2.13	224.0	84	162
05/06/93	FC-2	NA	NA	2.5	3.67	16.5	4230	3070	2110	0	398.0	176.0	222.0	0.57	1.79	216.0	88	228
05/06/93	FC-3	NA	NA	2.5	3.73	17.0	4300	3030	2090	0	310.0	6.6	303.4	1.07	1.84	256.0	93	260
05/06/93	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05/06/93	FC-5	NA	NA	2.6	3.93	18.0	4440	3300	1960	0	255.0	8.4	246.6	2.61	1.80	248.0	110	339
05/06/93	BWWND	NA	NA	8.3	0.55	15.0	325	53	0	230	0.2	0.1	0.1	0.01	0.03	0.1	37	64
06/07/93	FC-1	3.0	17.7	2.7	3.86	11.3	5290	3270	2700	0	582.0	200.0	382.0	0.54	2.95	222.0	90	182
06/07/93	FC-2	NA	NA	2.7	3.91	14.4	5310	3340	2450	0	464.0	210.0	254.0	0.92	1.89	219.0	94	291
06/07/93	FC-3	NA	NA	5.9	4.31	14.8	5060	3060	644	74	499.0	308.0	191.0	7.36	0.05	30.5	149	685
06/07/93	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
06/07/93	FC-5	NA	NA	2.7	4.33	12.6	4610	2970	989	0	217.0	47.9	169.1	7.63	0.12	13.4	155	641
06/07/93	BWWND	NA	NA	8.3	0.61	11.6	378	47	0	248	0.1	0.1	0.0	0.10	0.10	0.1	37	65
07/08/93	FC-1	3.6	23.5	2.8	3.36	12.9	4200	2540	1870	0	362.0	221.0	141.0	0.39	2.48	192.0	83	164
07/08/93	FC-2	***6.6***	***60.1***	2.7	3.71	13.8	4900	2940	2090	0	373.0	91.7	281.3	0.81	2.11	227.0	85	238
07/08/93	FC-3	NA	NA	2.7	3.56	14.4	4730	2850	2120	0	311.0	67.5	243.5	1.83	1.63	191.0	82	251
07/08/93	FC-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07/08/93	FC-5	NA	NA	2.8	3.40	12.7	3920	2400	1340	0	208.0	31.7	176.3	2.35	1.12	142.0	82	300
07/08/93	BWWND	NA	NA	7.3	0.63	11.6	400	103	0	201	3.3	0.4	2.9	0.08	0.03	3.1	31	76
10/22/93	FC-1	3.6	23.5	2.4	3.62	10.7	5320	3680	3180	0	555.0	324.0	231.0	0.47	4.91	290.0	91	178
10/22/93	FC-2	3.5	22.3	2.6	3.55	9.9	5600	3700	3020	0	467.0	270.0	197.0	0.66	4.63	309.0	94	247
10/22/93	FC-3	NA	NA	4.1	3.78	9.9	5380	3640	1930	0	413.0	295.0	118.0	3.64	0.98	185.0	134	547
10/22/93	FC-4	3.1	18.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10/22/93	FC-5	NA	NA	2.9	3.75	5.1	5070	3530	1840	0	354.0	236.0	118.0	4.91	1.48	173.0	141	547
10/22/93	BWWND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

FC-1 = No. 1 Flume; FC-2 = No. 2 Flume; FC-3 = No. 3 Flume; FC-4 = No. 4 Flume; FC-5 = No. 5 Flume;BWWND = Natural Drainage at Tracks

Bold,italic data are questionable values and were deleted for data analysis purposes.

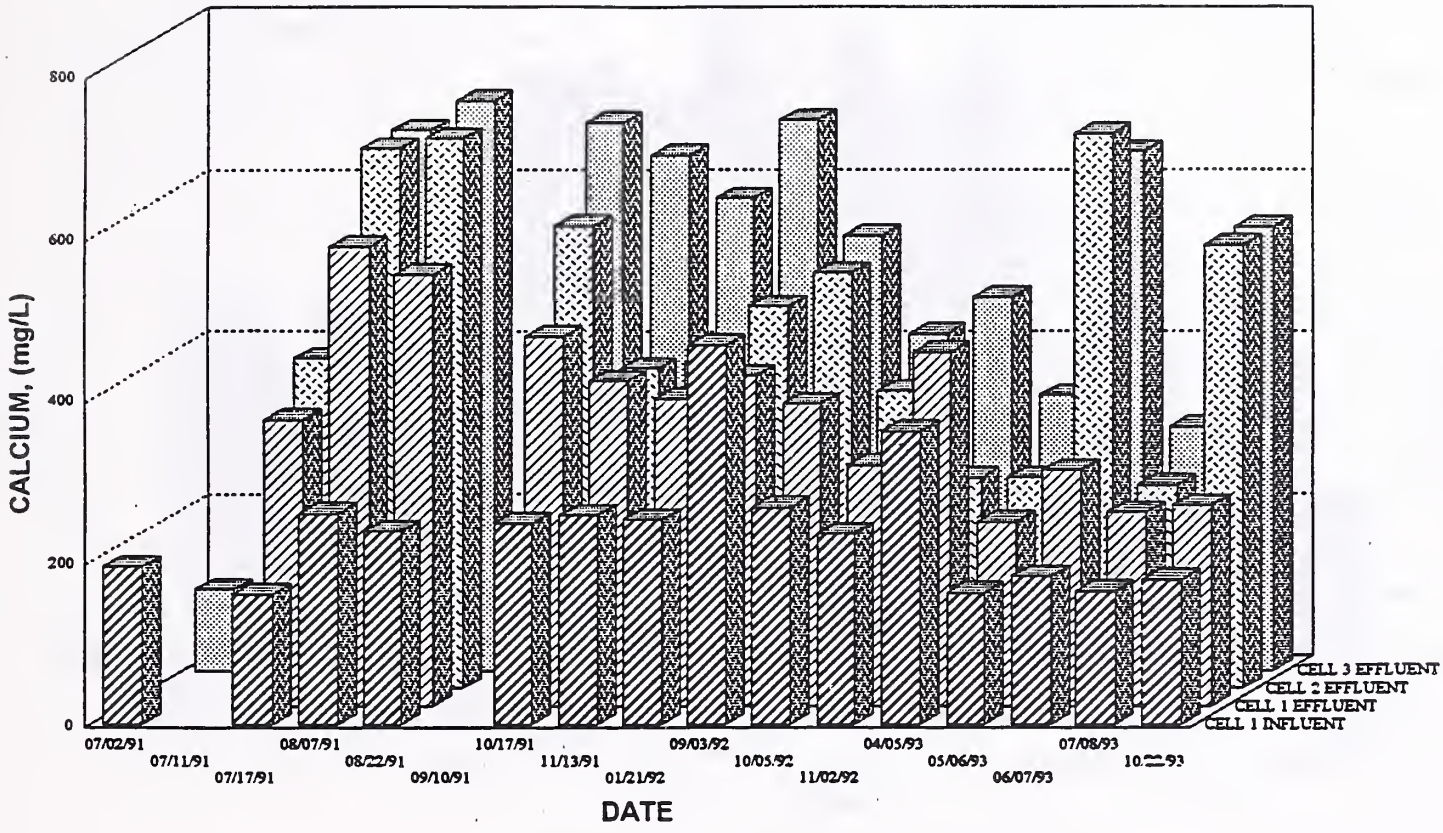

Figure A.1 Calcium analyses at the French Coulee Wetland since start-up.

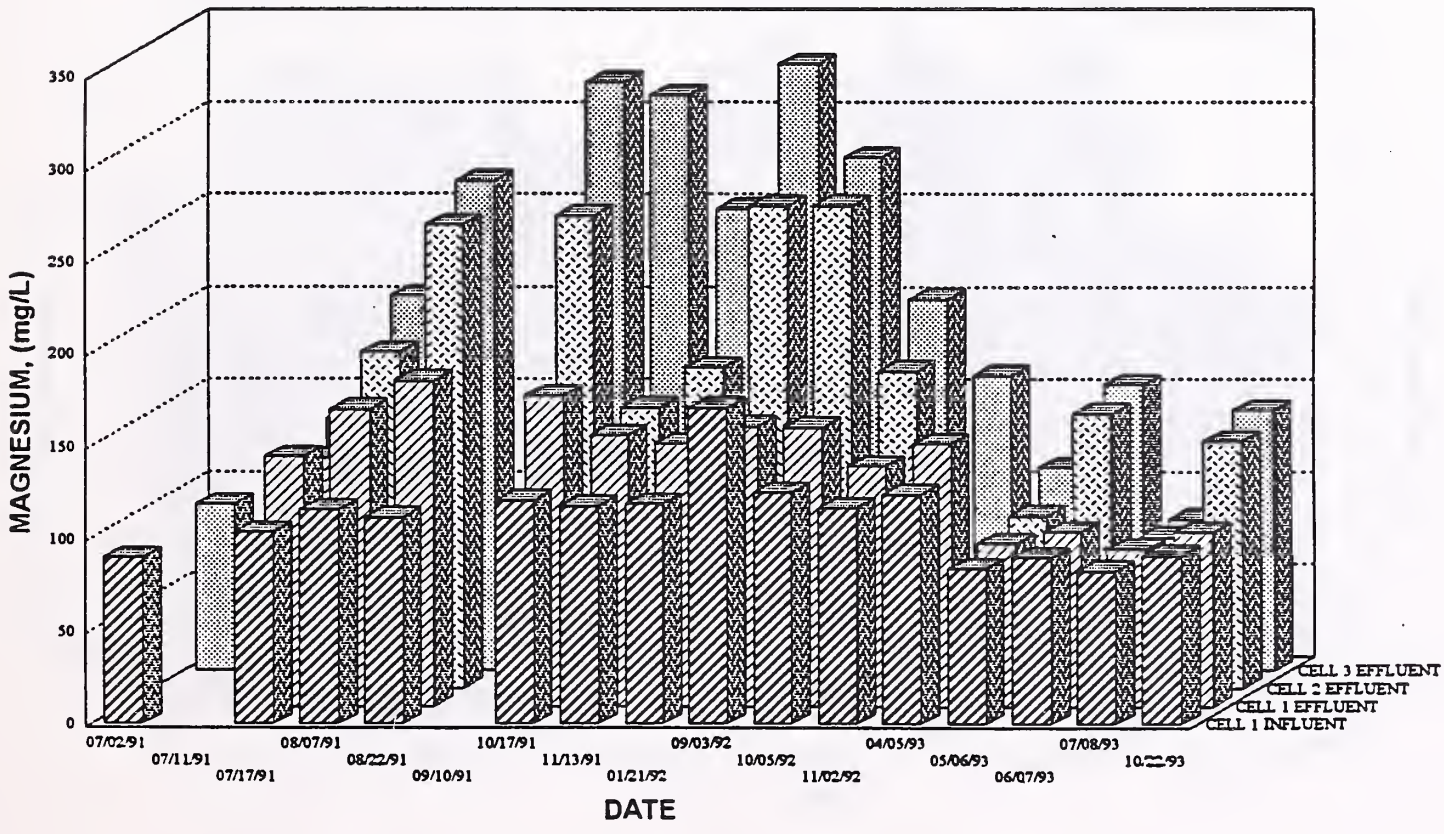

Figure A.2 Magnesium analyses at the French Coulee Wetland since start-up.

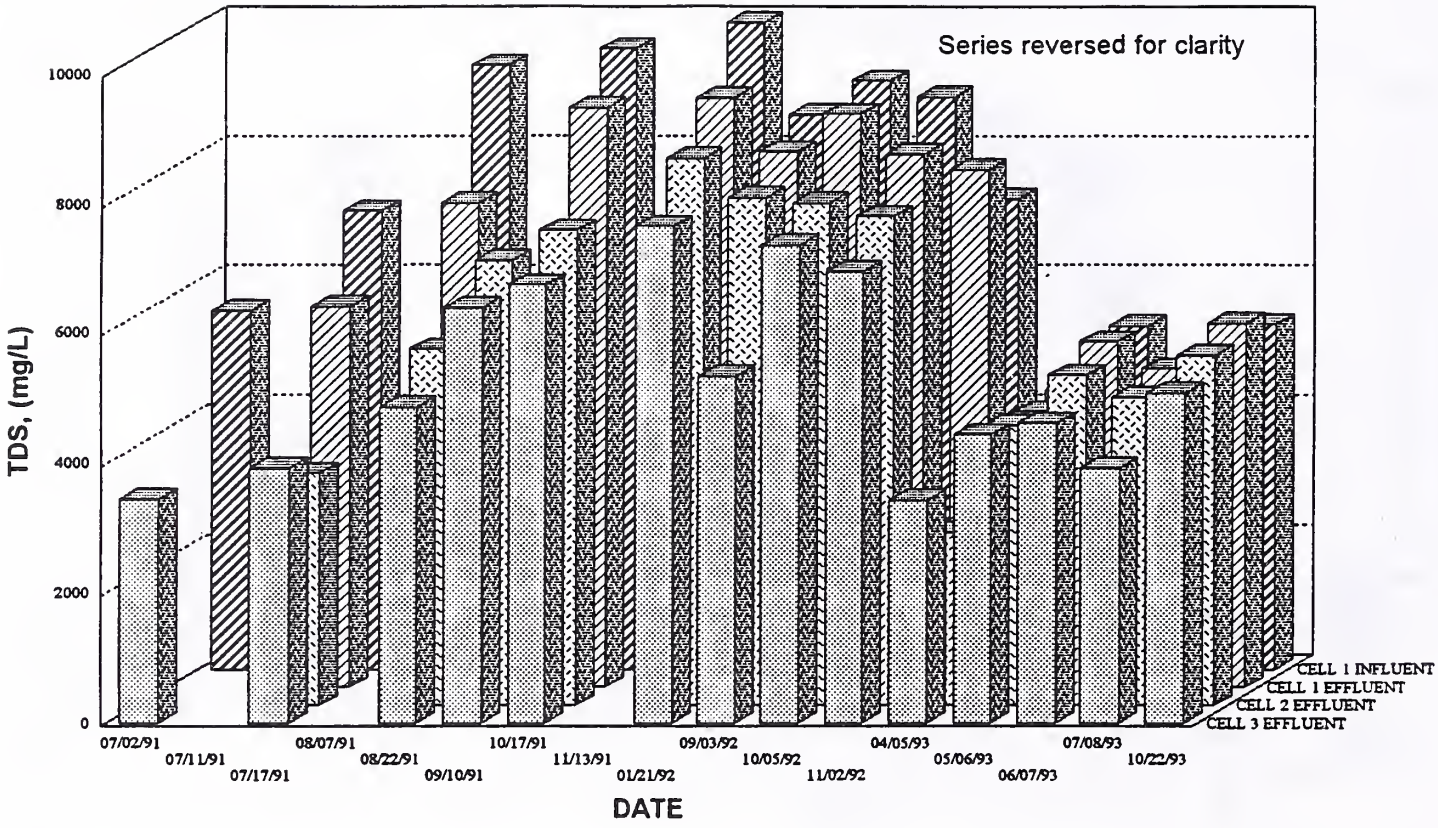

Figure A.3 TDS analyses at the French Coulee Wetland since start-up.

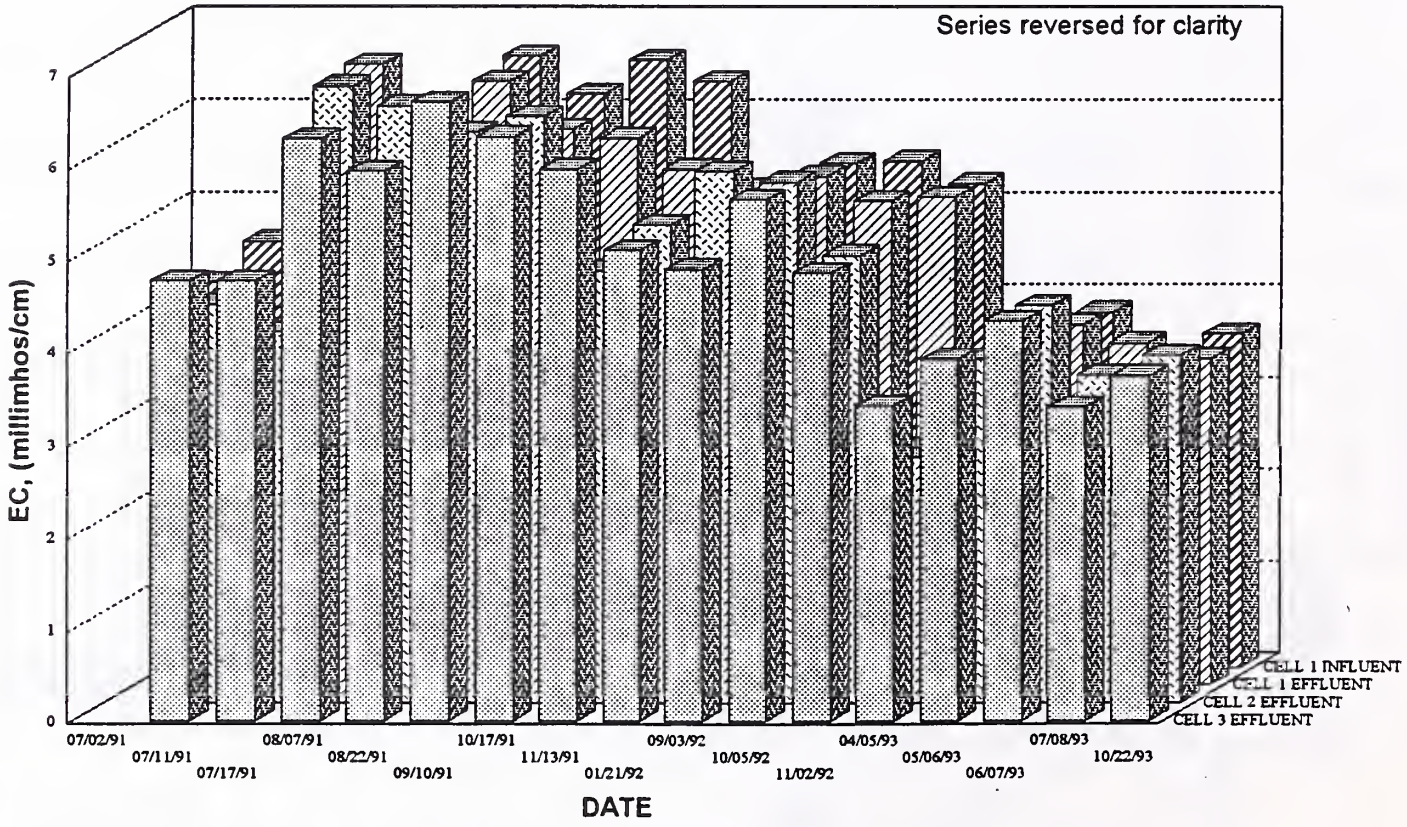

Figure A.4 EC of waters at the French Coulee Wetland since start-up.

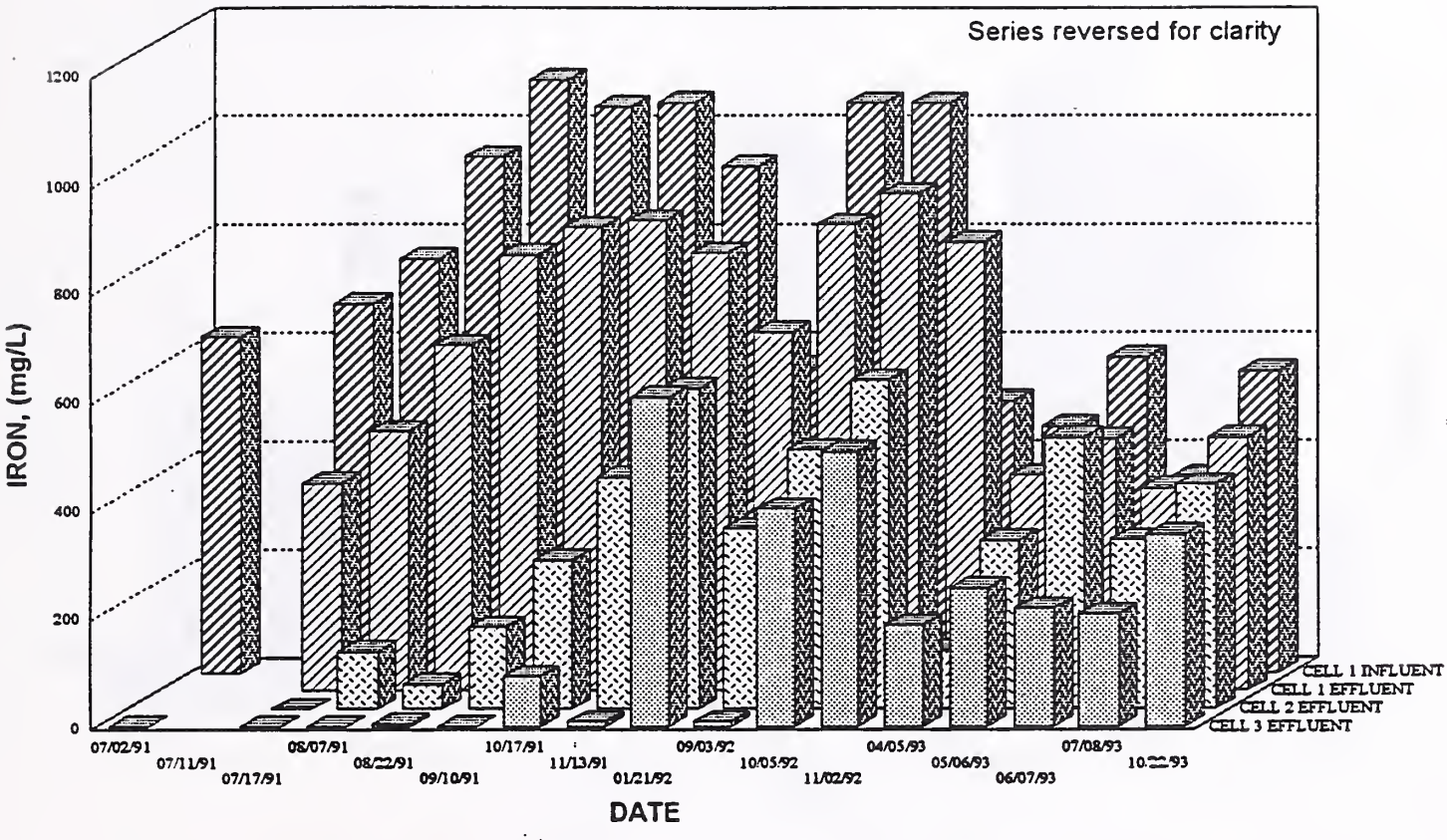

Figure A.5 Iron analyses at the French Coulee Wetland since start-up.

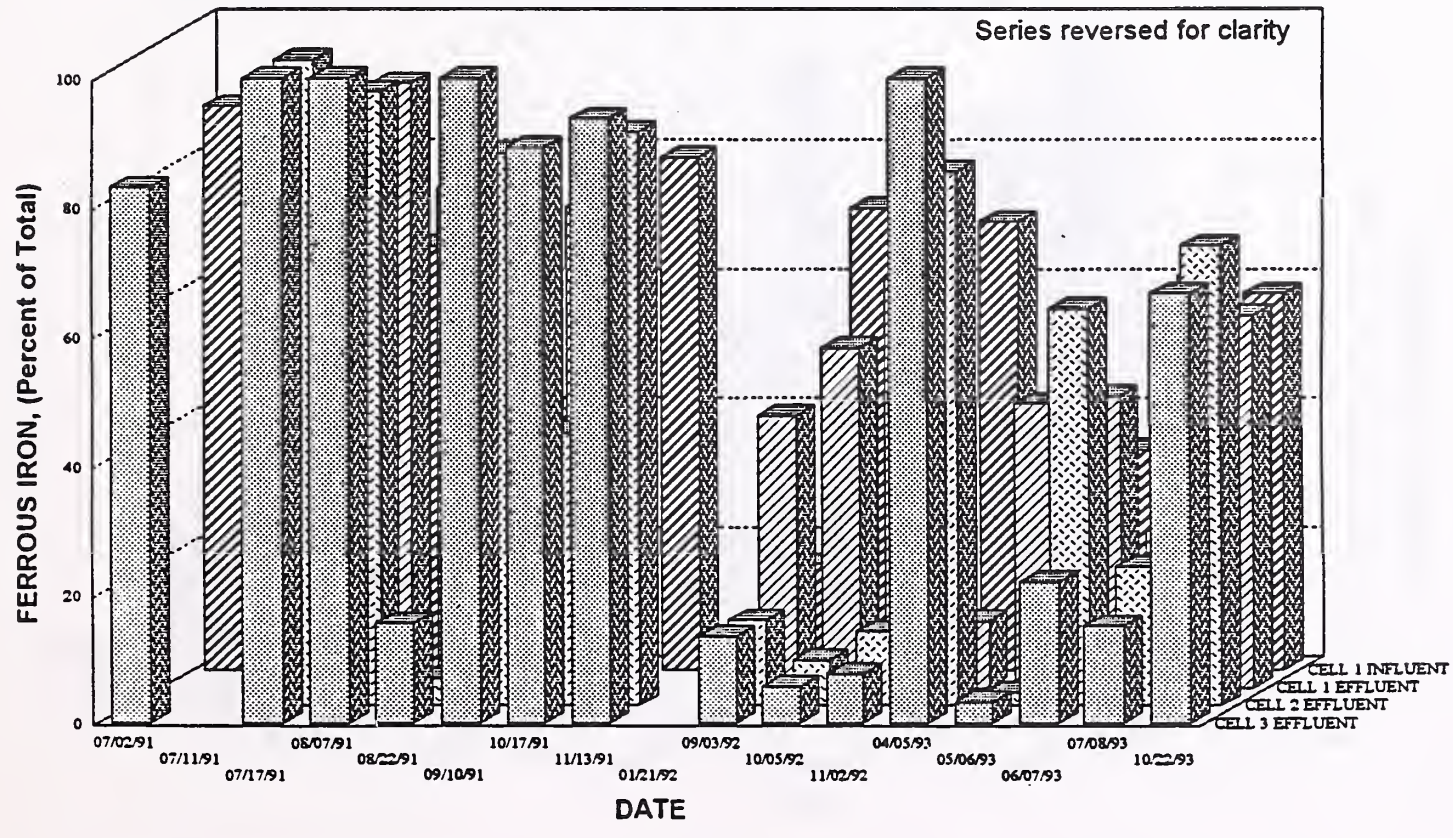

Figure A.6 Ferrous/Ferric ratios at the French Coulee Wetland since start-up.

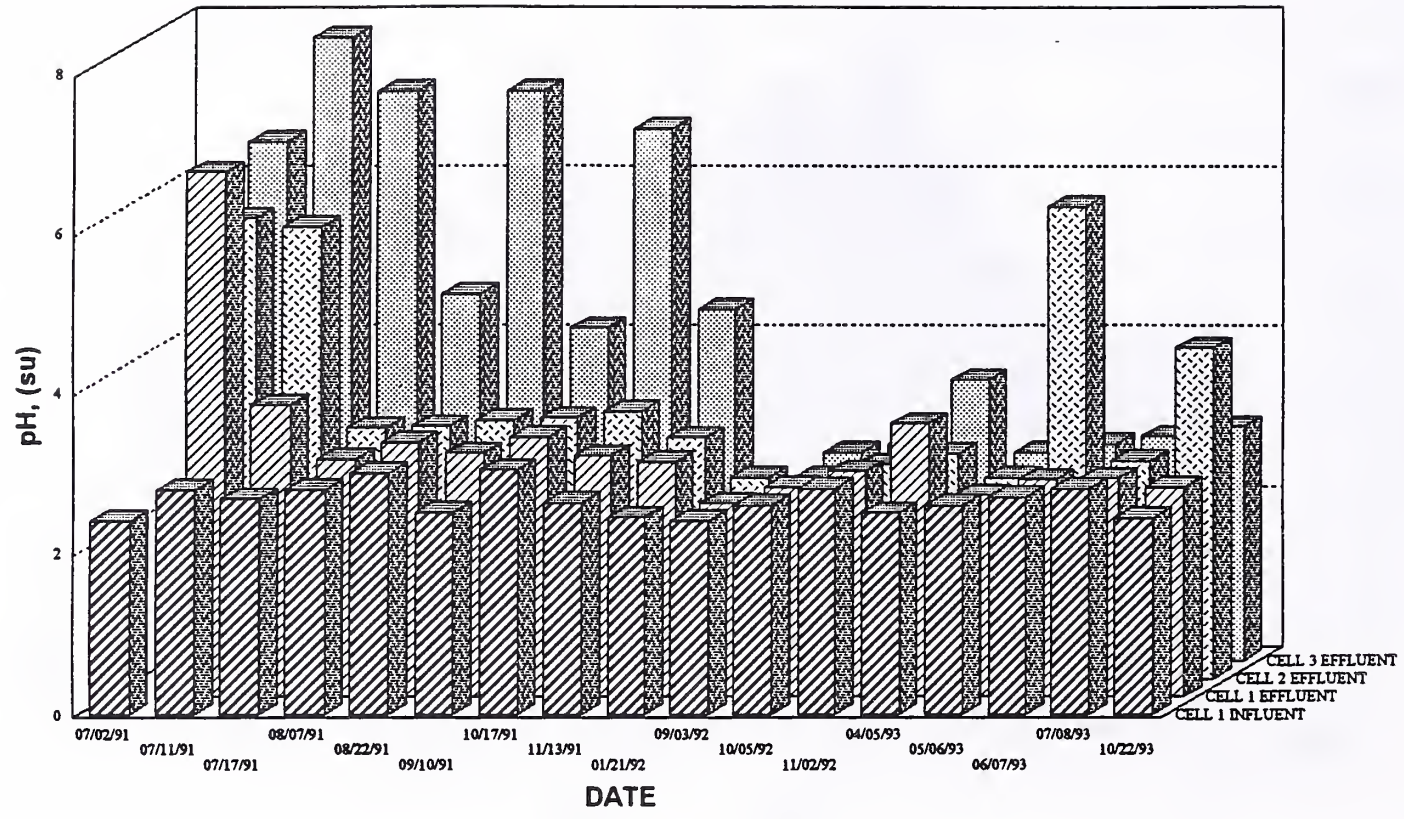

Figure A.7 pH measurements at the French Coulee Wetland since start-up.

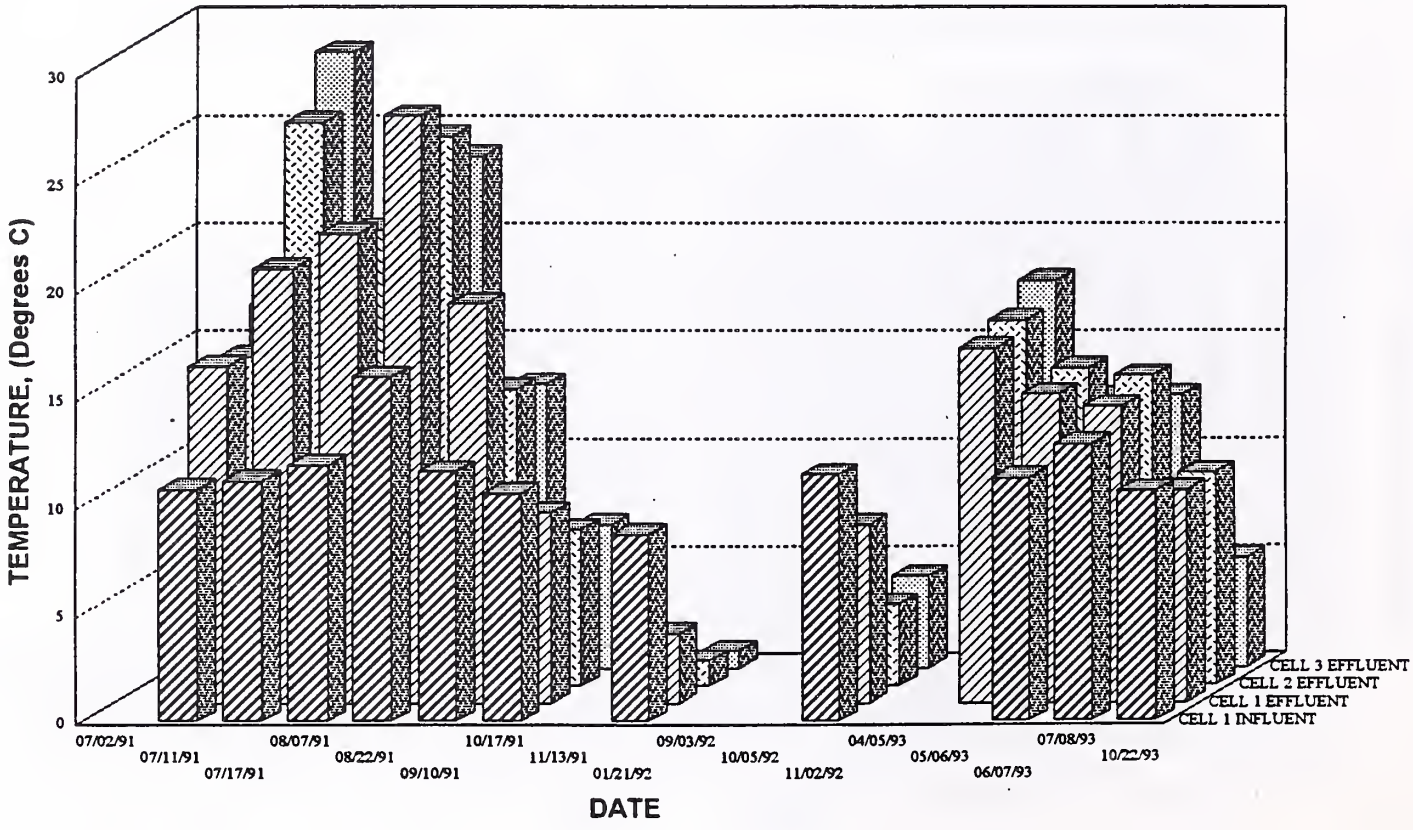

Figure A.8 Temperature measurements at the French Coulee Wetland since start-up.

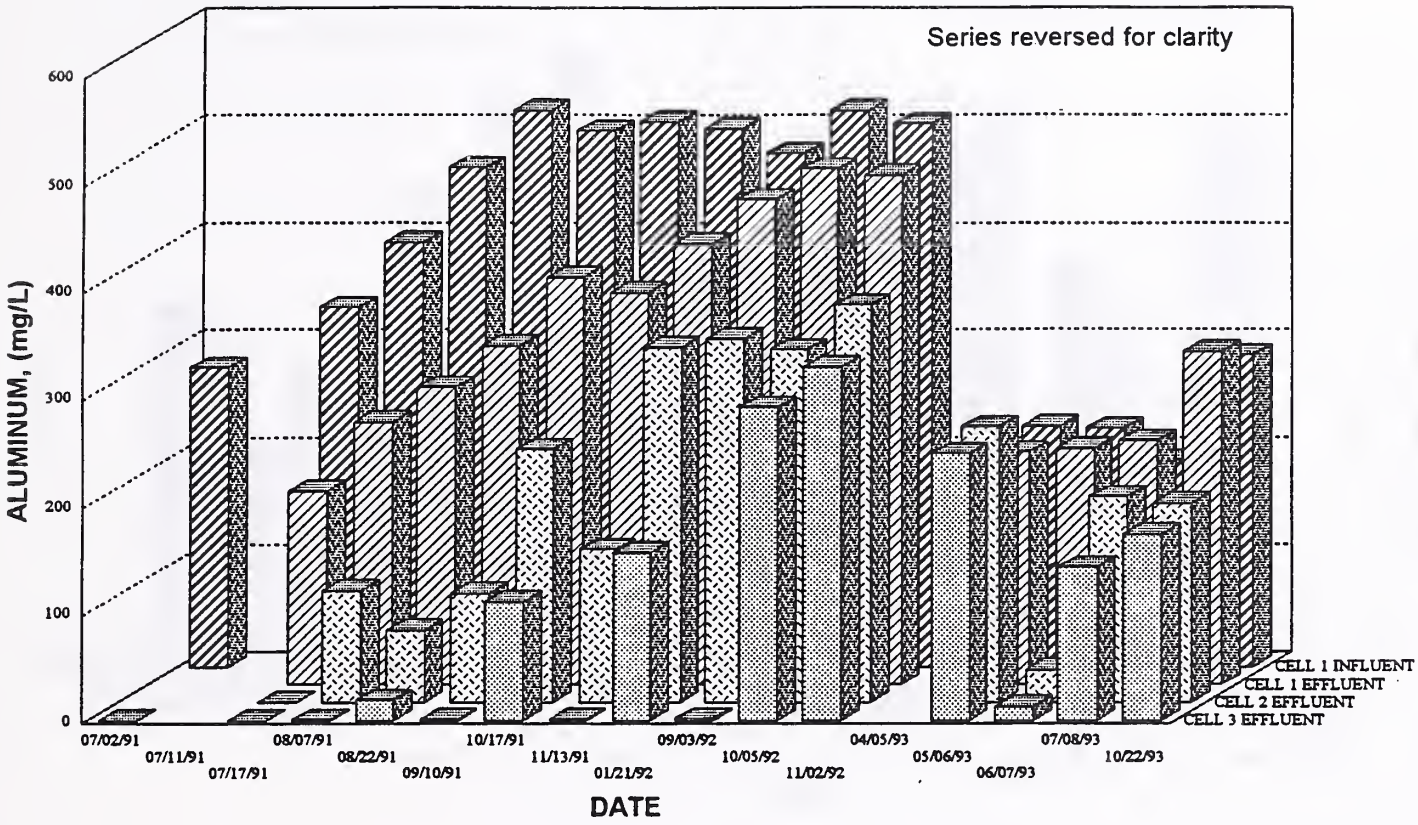

Figure A.9 Aluminum analyses at the French Coulee Wetland since start-up.

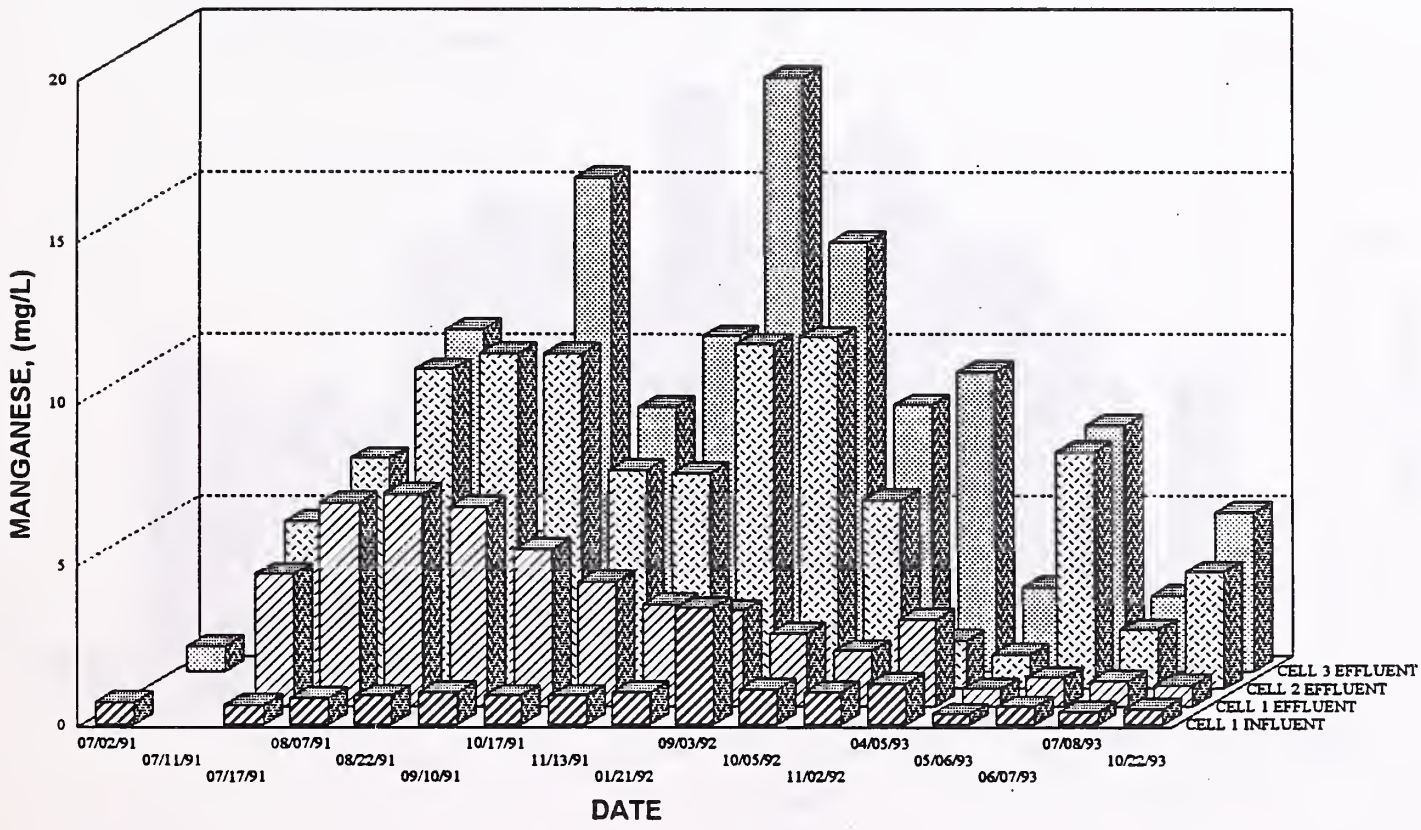

Figure A.10 Manganese analyses at the French Coulee Wetland since start-up.

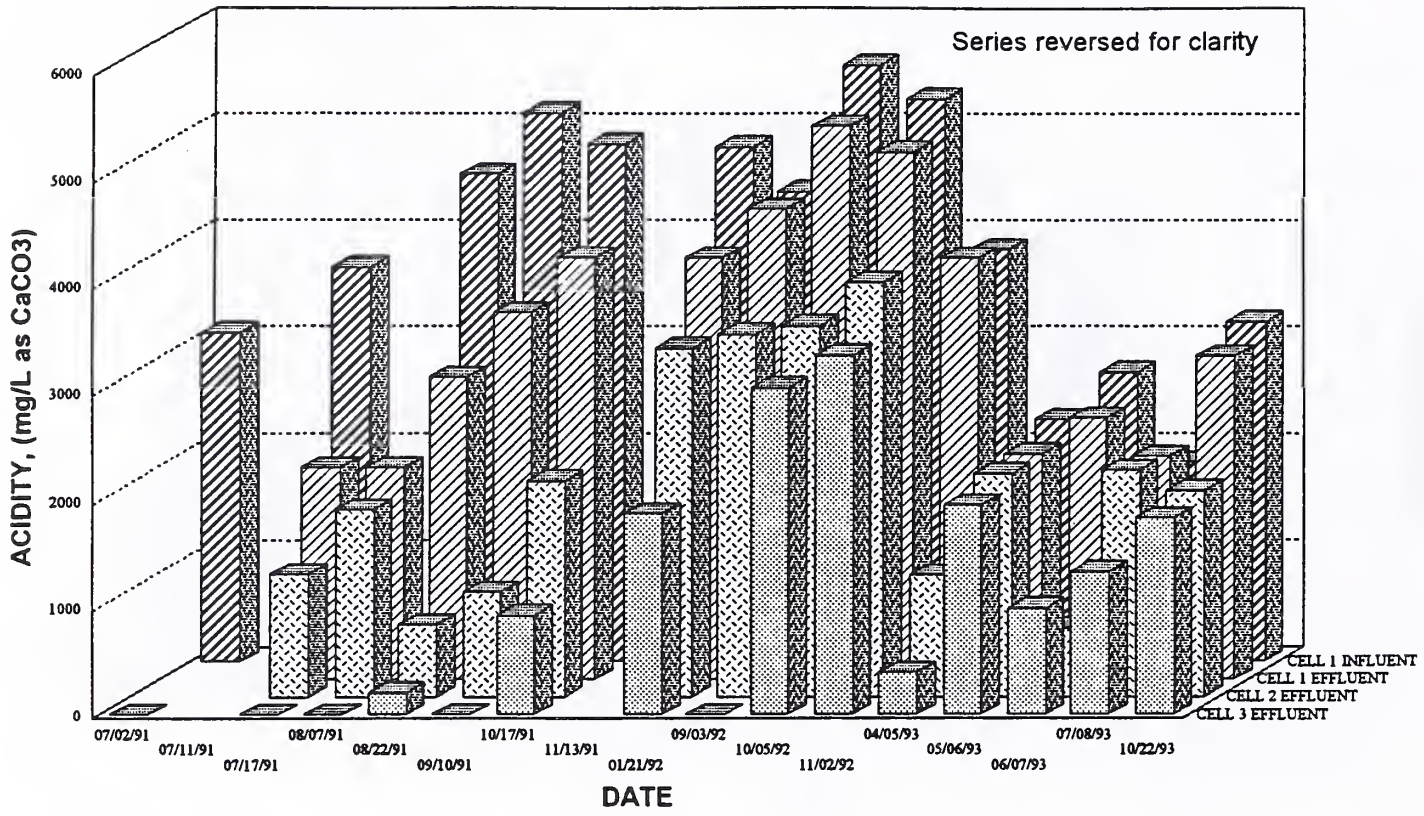

Figure A.11 Acidity analyses at the French Coulee Wetland since start-up.

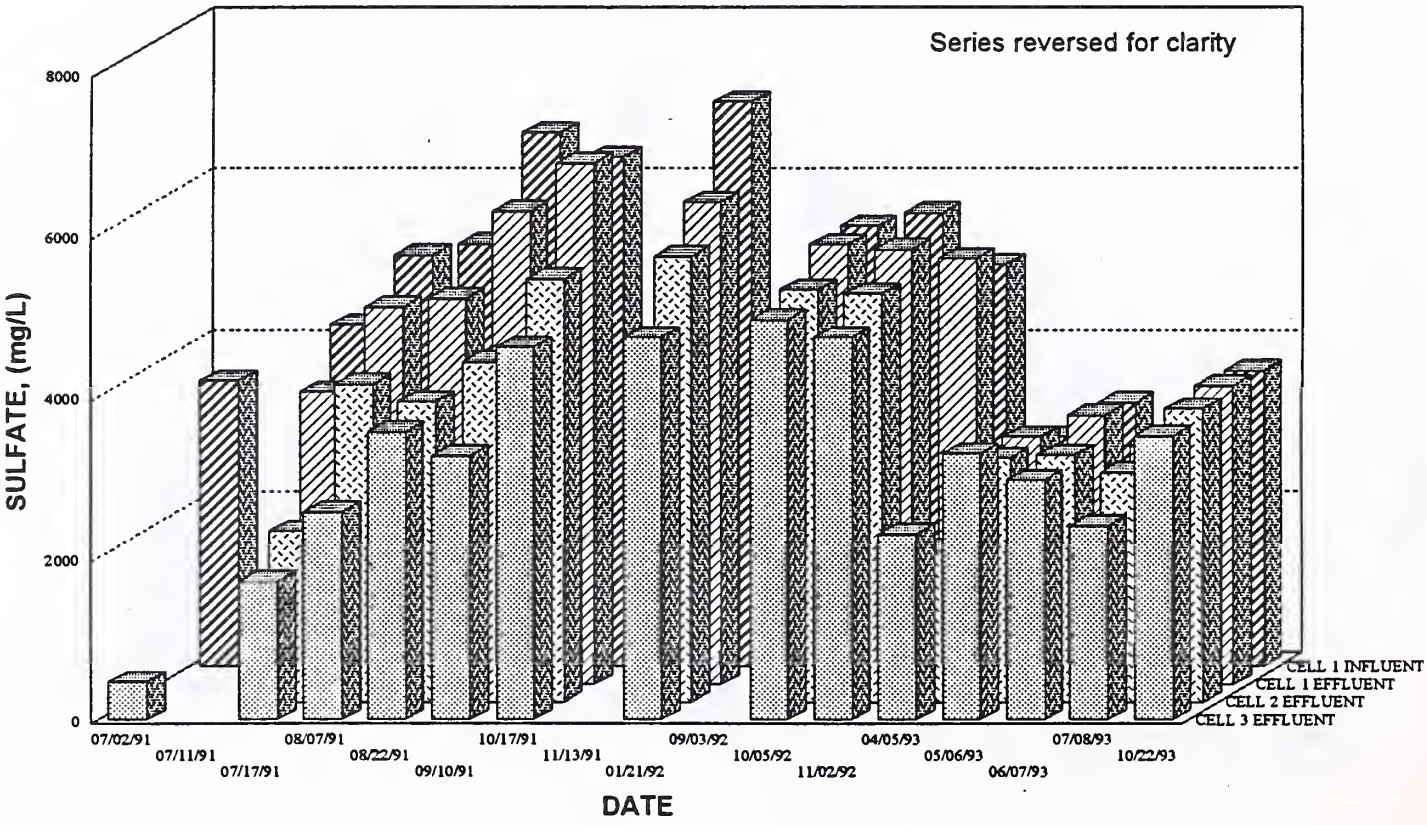

Figure A.12 Sulfate analyses at the French Coulee Wetland since start-up.

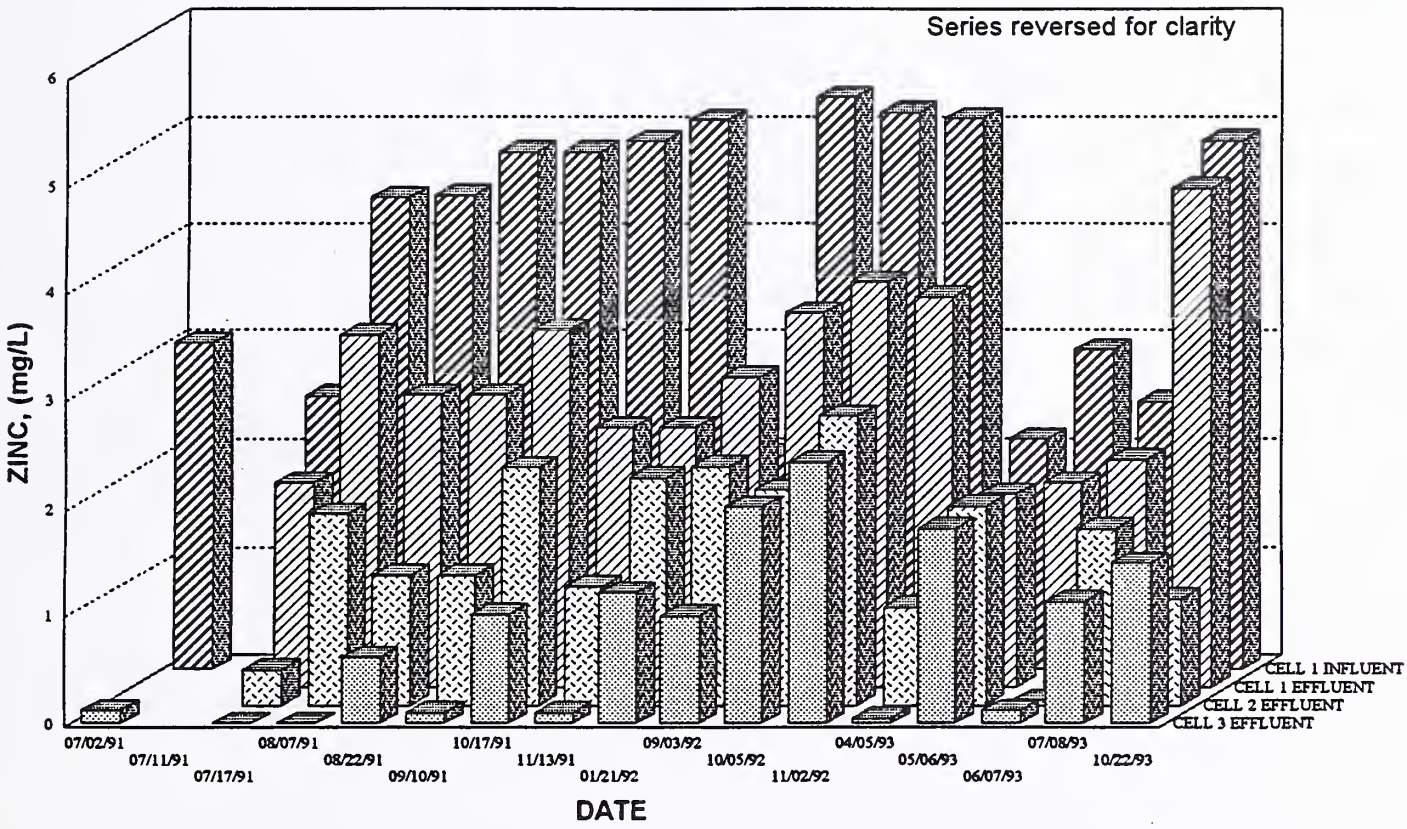

Figure A.13 Zinc analyses at the French Coulee Wetland since start-up.

APPENDIX B

Centerville "C" Wetland
Data Tables, Charts and Laboratory Reports

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39253
DATE: 10/15/92 crp

WATER ANALYSIS

Centerville Wetland
Cell I Influent, CWW1I-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.5	s.u.
Specific Conductance @ 25°C	3710	µmhos/cm
Total Acidity as $CaCO_3$	2400	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	4130	
Magnesium	94	
Calcium	201	
Sulfate	2760	
Nitrate plus Nitrite as N	0.30	
Ferrous Iron	2.3	
Ferric Iron	266	
Dissolved Metals		
Aluminum	241	
Iron	268	
Manganese	1.77	
Zinc	2.88	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39254
DATE: 10/15/92 crp

WATER ANALYSIS

Centerville Wetland
Cell I Effluent, CWW1E-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	3.0	s.u.
Specific Conductance @ 25°C	3500	µmhos/cm
Total Acidity as $CaCO_3$	1480	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	4020	
Magnesium	123	
Calcium	417	
Sulfate	2660	
Nitrate plus Nitrite as N	0.86	
Ferrous Iron	34.8	
Ferric Iron	80.2	
Dissolved Metals		
Aluminum	181	
Iron	115	
Manganese	3.60	
Zinc	2.96	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39255
DATE: 10/15/92 crp

WATER ANALYSIS

Centerville Wetland
Cell II Effluent, CWW2E-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	7.6	s.u.
Specific Conductance @ 25°C	5300	µmhos/cm
Total Acidity as $CaCO_3$	0	
Total Alkalinity as $CaCO_3$	889	
Total Dissolved Solids @ 180°C	5040	
Magnesium	209	
Calcium	536	
Sulfate	2000	
Nitrate plus Nitrite as N	0.07	
Ferrous Iron	4.2	
Ferric Iron	1.0	
Dissolved Metals		
Aluminum	2.4	
Iron	5.21	
Manganese	4.10	
Zinc	0.08	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39256
DATE: 10/15/92 crp

WATER ANALYSIS

Centerville Wetland
Cell III Effluent, CWW3E-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	7.7	s.u.
Specific Conductance @ 25°C	5640	µmhos/cm
Total Acidity as $CaCO_3$	0	
Total Alkalinity as $CaCO_3$	1230	
Total Dissolved Solids @ 180°C	5140	
Magnesium	245	
Calcium	455	
Sulfate	1750	
Nitrate plus Nitrite as N	0.06	
Ferrous Iron	7.2	
Ferric Iron	1.0	
Dissolved Metals		
Aluminum	1.2	
Iron	8.18	
Manganese	5.98	
Zinc	0.08	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39257
DATE: 10/15/92 crp

WATER ANALYSIS

Centerville Wetland
Catchment Basin
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	3.4	s.u.
Specific Conductance @ 25°C	3340	µmhos/cm
Total Acidity as $CaCO_3$	1870	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	4350	
Magnesium	138	
Calcium	391	
Sulfate	2880	
Nitrate plus Nitrite as N	1.36	
Ferrous Iron	2.5	
Ferric Iron	1.9	
Dissolved Metals		
Aluminum	277	
Iron	4.37	
Manganese	3.57	
Zinc	2.49	

LABORATORIES — HOLT, MI 48842

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
	CENTERVILLE WETLAND

SAMPLERS: (Signature) EARL McCurley Earl McCurley

STAT. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS
CELL I INFLUENT	10/2			✓	CELL I INFLUENT CWWII-10-1	3
↕	↕				NONE, HCL, HNO3	↕
CELL I EFFLUENT	10/2			✓	CELL I EFFLUENT CWWIE-10-1	3
↕	↕			✓	NONE, HCL, HNO3	↕
CELL II EFFLUENT	10/2			✓	CELL II EFFLUENT CWW2E-10-1	3
↕	↕				NONE, HCL, HNO3	↕
CELL III EFFLUENT	10/2			✓	CELL III EFFLUENT CWW3E-10-1	3
↕	↕				NONE, HCL, HNO3	↕
CATCHMENT BASIN	10/2			✓	CATCHMENT BASIN H2O	3
↕	↕				NONE, HCL, HNO3	3

REMARKS: CENTERVILLE WETLANDS

ALL SAMPLES RUN for:

pH, SC, ACIDITY, ALKALINITY, TDS, MN, Mg, AL, Fe, CA, ZN, Ferric & Ferrous Iron, Sulfate, Nitrate?

Samples taken between 11:00 - 2:30 PM 10-2-92

Relinquished (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Earl McCurley	10-2-92 4:00 PM				
Relinquished (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	
		Dawn Stevenson	10/5/92 10:21		

Split Samples:
[] Accepted [] Declined ——— Signature

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45479
DATE: 11/17/92 da

WATER ANALYSIS

Centerville Wetlands
CWW1I-11-2
Cell I Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	742	
Magnesium	92	
Sulfate	2450	
Total Dissolved Solids @ 180° C	3760	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	353	
Specific Conductance @ 25° C	3190	µmhos/cm
pH	4.5	s.u.
Nitrate plus Nitrite as N	0.41	

Total Metals

Aluminum	59.9	
Iron	85.4	
Ferrous Iron	33.4	
Ferric Iron	52.0	
Manganese	1.71	
Zinc	2.11	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45478
DATE: 11/17/92 da

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STATE LANDS

WATER ANALYSIS

Centerville Wetlands
CWW1I-11-2LMS
Cell I Influent (Limestone)
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	682	
Magnesium	90	
Sulfate	2560	
Total Dissolved Solids @ 180° C	3820	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	586	
Specific Conductance @ 25° C	3210	µmhos/cm
pH	4.2	s.u.
Nitrate plus Nitrite as N	0.40	

Total Metals

Aluminum	75.7	
Iron	98.3	
Ferrous Iron	37.4	
Ferric Iron	60.9	
Manganese	1.66	
Zinc	2.09	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45480
DATE: 11/17/92 da

WATER ANALYSIS

Centerville Wetlands
CWW1E-11-2
Cell I Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	758	
Magnesium	103	
Sulfate	2250	
Total Dissolved Solids @ 180° C	3740	
Total Alkalinity as $CaCO_3$	241	
Total Acidity as $CaCO_3$	0	
Specific Conductance @ 25° C	3360	µmhos/cm
pH	6.4	s.u.
Nitrate plus Nitrite as N	0.98	

Total Metals

Aluminum	2.2	
Iron	16.5	
Ferrous Iron	11.7	
Ferric Iron	4.8	
Manganese	2.51	
Zinc	1.37	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45480 dup
DATE: 11/17/92 da

QUALITY ASSURANCE-DUPLICATE ANALYSIS

Centerville Wetlands
CWW1E-11-2
Cell I Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	767	
Magnesium	104	
Sulfate	2290	
Total Dissolved Solids @ 180° C	3740	
Total Alkalinity as $CaCO_3$	241	
Total Acidity as $CaCO_3$	0	
Specific Conductance @ 25° C	3370	µmhos/cm
pH	6.4	s.u.
Nitrate plus Nitrite as N	0.97	

Total Metals

Aluminum	2.1	
Iron	16.8	
Ferrous Iron	11.5	
Ferric Iron	5.3	
Manganese	2.59	
Zinc	1.47	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45481
DATE: 11/17/92 da

WATER ANALYSIS

Centerville Wetlands
CWW2E-11-2
Cell II Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	561	
Magnesium	136	
Sulfate	1900	
Total Dissolved Solids @ 180° C	3860	
Total Alkalinity as $CaCO_3$	580	
Total Acidity as $CaCO_3$	0	
Specific Conductance @ 25° C	4090	µmhos/cm
pH	7.6	s.u.
Nitrate plus Nitrite as N	0.06	

Total Metals

Aluminum	0.1	
Iron	1.28	
Ferrous Iron	1.3	
Ferric Iron	<0.1	
Manganese	3.00	
Zinc	0.03	

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45481 spi
DATE: 11/17/92 da

QUALITY ASSURANCE-SPIKED ANALYSIS

Centerville Wetlands
CWW2E-11-2
Cell II Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	% Recovery	
Calcium	98	
Magnesium	96	
Sulfate	100	
Total Dissolved Solids @ 180° C	N/A	
Total Alkalinity as $CaCO_3$	N/A	
Total Acidity as $CaCO_3$	N/A	
Specific Conductance @ 25° C	N/A	µmhos/cm
pH	N/A	s.u.
Nitrate plus Nitrite as N	101	
Total Metals		
Aluminum	99	
Iron	101	
Ferrous Iron	95	
Ferric Iron	N/A	
Manganese	101	
Zinc	101	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45482
DATE: 11/17/92 da

WATER ANALYSIS

Centerville Wetlands
CWW3E-11-2
Cell 3 Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	495	
Magnesium	155	
Sulfate	1880	
Total Dissolved Solids @ 180° C	3970	
Total Alkalinity as $CaCO_3$	748	
Total Acidity as $CaCO_3$	0	
Specific Conductance @ 25° C	4290	µmhos/cm
pH	7.8	s.u.
Nitrate plus Nitrite as N	0.14	

Total Metals

Aluminum	<0.1	
Iron	4.38	
Ferrous Iron	4.3	
Ferric Iron	<0.1	
Manganese	4.85	
Zinc	0.02	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45483
DATE: 11/17/92 da

WATER ANALYSIS

Centerville Wetlands
CWWCB-11-2
Catchment Basin
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	331	
Magnesium	117	
Sulfate	2720	
Total Dissolved Solids @ 180° C	4030	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	1560	
Specific Conductance @ 25° C	3040	µmhos/cm
pH	3.5	s.u.
Nitrate plus Nitrite as N	1.54	

Total Metals

Aluminum	223	
Iron	2.93	
Ferrous Iron	2.0	
Ferric Iron	0.9	
Manganese	3.25	
Zinc	2.09	

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12945
DATE: 04/15/93 ag

WATER ANALYSIS

Centerville Wetlands
Cell I Influent, CWW1I-4-5
Sampled 04/05/93
Submitted 04/06/93

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Constituent	mg/l (ppm)		Date Analyzed
Calcium	311		04/13/93
Magnesium	113		04/13/93
Sulfate	2720		04/08/93
Total Dissolved Solids @ 180°	3910		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	1800		04/08/93
Specific Conductance @ 25°C	3290	µmhos/cm	04/07/93
pH	2.8	s.u.	04/07/93
Nitrate plus Nitrite as N	1.23		04/09/93
Total Metals			
Iron	100		04/06/93
Ferric Iron	91.0		04/07/93
Ferrous Iron	9.0		04/07/93
Manganese	2.78		04/12/93
Zinc	1.95		04/12/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12946
DATE: 04/15/93 ag

WATER ANALYSIS

Centerville Wetlands
Cell 2 Effluent, CWW2E-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	426		04/13/93
Magnesium	121		04/13/93
Sulfate	2310		04/08/93
Total Dissolved Solids @ 180°C	3490		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	786		04/08/93
Specific Conductance @ 25°C	3400	µmhos/cm	04/07/93
pH	3.2	s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05		04/09/93
Total Metals			
Iron	54.5		04/06/93
Ferric Iron	14.2		04/07/93
Ferrous Iron	40.3		04/07/93
Manganese	4.12		04/08/93
Zinc	1.33		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12947
DATE: 04/15/93 ag

WATER ANALYSIS

Centerville Wetlands
Cell 3 Effluent, CWW3E-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	522		04/13/93
Magnesium	164		04/13/93
Sulfate	2130		04/08/93
Total Dissolved Solids @ 180°C	3720		04/07/93
Total Alkalinity as $CaCO_3$	392		04/07/93
Total Acidity as $CaCO_3$	40		04/08/93
Specific Conductance @ 25°C	4240	µmhos/cm	04/07/93
pH	6.8	s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05		04/09/93
Total Metals			
Iron	18.9		04/06/93
Ferric Iron	7.6		04/07/93
Ferrous Iron	11.3		04/07/93
Manganese	11.8		04/08/93
Zinc	0.04		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12948
DATE: 04/15/93 ag

WATER ANALYSIS

Centerville Wetlands
Catchment Basin, CWWCB-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	369		04/13/93
Magnesium	124		04/13/93
Sulfate	2540		04/08/93
Total Dissolved Solids @ 180°C	3650		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	1300		04/08/93
Specific Conductance @ 25°C	2960	µmhos/cm	04/07/93
pH	3.6	s.u.	04/07/93
Nitrate plus Nitrite as N	2.05		04/09/93
Total Metals			
Iron	1.83		04/06/93
Ferric Iron	0.1		04/07/93
Ferrous Iron	1.7		04/07/93
Manganese	3.60		04/08/93
Zinc	1.80		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18020
DATE: 05/21/93 crp

WATER ANALYSIS

Centerville, CWW1I-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	542		05/11/93
Magnesium	107		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	918		05/11/93
Specific Conductance @ 25°C	3280	µmhos/cm	05/10/93
pH	3.9	s.u.	05/10/93
Sulfate	2700		05/15/93
Nitrate plus Nitrite as N	1.19		05/10/93
Total Dissolved Solids @ 180°C	3790		05/11/93
Total Metals			
Aluminum	223		05/17/93
Iron	147		05/07/93
Ferric Iron	136		05/07/93
Ferrous Iron	11.1		05/07/93
Manganese	2.53		05/11/93
Zinc	2.10		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18020 dup
DATE: 05/21/93 crp

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Centerville, CWW11-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	512		05/11/93
Magnesium	98		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	919		05/11/93
Specific Conductance @ 25°C	3280	µmhos/cm	05/10/93
pH	3.9	s.u.	05/10/93
Sulfate	2730		05/15/93
Nitrate plus Nitrite as N	1.17		05/10/93
Total Dissolved Solids @ 180°C	3800		05/11/93
Total Metals			
Aluminum	228		05/17/93
Iron	159		05/07/93
Ferric Iron	148		05/07/93
Ferrous Iron	11.3		05/07/93
Manganese	2.69		05/11/93
Zinc	2.32		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18021
DATE: 05/21/93 crp

WATER ANALYSIS

Centerville, CWW1E-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	616		05/11/93
Magnesium	101		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	832		05/11/93
Specific Conductance @ 25°C	3530	µmhos/cm	05/10/93
pH	3.3	s.u.	05/10/93
Sulfate	2700		05/15/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	3800		05/11/93
Total Metals			
Aluminum	96.3		05/17/93
Iron	24.7		05/07/93
Ferric Iron	6.4		05/07/93
Ferrous Iron	18.3		05/07/93
Manganese	2.63		05/11/93
Zinc	2.79		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18021 spi
DATE: 05/21/93 crp

QUALITY ASSURANCE - SPIKED ANALYSIS

Centerville, CWW1E-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	% Recovery		Date Analyzed
Calcium	111		05/11/93
Magnesium	112		05/11/93
Total Alkalinity as $CaCO_3$	N/A		N/A
Total Acidity as $CaCO_3$	N/A		N/A
Specific Conductance @ 25°C	N/A	µmhos/cm	N/A
pH	N/A	s.u.	N/A
Sulfate	102		05/14/93
Nitrate plus Nitrite as N	92		05/10/93
Total Dissolved Solids @ 180°C	N/A		N/A
Total Metals			
Aluminum	102		05/17/93
Iron	98		05/07/93
Ferric Iron	N/A		N/A
Ferrous Iron	94		05/07/93
Manganese	103		05/11/93
Zinc	115		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18022
DATE: 05/21/93 crp

WATER ANALYSIS

Centerville, CWW2E-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	719		05/11/93
Magnesium	140		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	355		05/11/93
Specific Conductance @ 25°C	3790	µmhos/cm	05/10/93
pH	3.3	s.u.	05/10/93
Sulfate	2680		05/15/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	3810		05/11/93
Total Metals			
Aluminum	38.8		05/17/93
Iron	8.71		05/07/93
Ferric Iron	4.5		05/07/93
Ferrous Iron	4.2		05/07/93
Manganese	4.84		05/11/93
Zinc	0.96		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18023
DATE: 05/21/93 crp

WATER ANALYSIS

Centerville, CWW3E-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	680		05/11/93
Magnesium	133		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	281		05/11/93
Specific Conductance @ 25°C	3740	µmhos/cm	05/10/93
pH	4.0	s.u.	05/10/93
Sulfate	2540		05/15/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	3860		05/11/93
Total Metals			
Aluminum	42.6		05/17/93
Iron	4.45		05/07/93
Ferric Iron	1.4		05/07/93
Ferrous Iron	3.0		05/07/93
Manganese	5.76		05/11/93
Zinc	1.77		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18024
DATE: 05/21/93 crp

WATER ANALYSIS

Centerville, CWWCB-5-6
Sampled 05/06/93 @ 0900
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	342		05/11/93
Magnesium	122		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	1700		05/11/93
Specific Conductance @ 25°C	3140	µmhos/cm	05/10/93
pH	3.4	s.u.	05/10/93
Sulfate	2590		05/15/93
Nitrate plus Nitrite as N	2.41		05/10/93
Total Dissolved Solids @ 180°C	3720		05/11/93
Total Metals			
Aluminum	221		05/17/93
Iron	2.90		05/07/93
Ferric Iron	0.6		05/07/93
Ferrous Iron	2.3		05/07/93
Manganese	4.30		05/11/93
Zinc	3.28		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22417
DATE: 06/23/93 dlf

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STATE LANDS

WATER ANALYSIS

Centerville Wetlands
CWW11-6-7, LMS, Cell I Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	391		06/10/93
Magnesium	117		06/10/93
Sulfate	2530		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	3820		06/09/93
Specific Conductance @ 25°C	3020	µmhos/cm	06/09/93
pH	3.5	s.u.	06/09/93
Total Acidity as $CaCO_3$	1220		06/09/93
Nitrate plus Nitrite as N	2.00		06/16/93
Total Metals			
Aluminum	198		06/11/93
Iron	160		06/10/93
Ferrous Iron	4.3		06/11/93
Ferric Iron	156		06/11/93
Manganese	3.38		06/10/93
Zinc	1.73		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22418
DATE: 06/23/93 dlf

WATER ANALYSIS

Centerville Wetlands
CWW1E-6-7, Cell I Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	612		06/10/93
Magnesium	124		06/10/93
Sulfate	2350		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	3630		06/09/93
Specific Conductance @ 25°C	3520	µmhos/cm	06/09/93
pH	3.3	s.u.	06/09/93
Total Acidity as $CaCO_3$	223		06/09/93
Nitrate plus Nitrite as N	<0.05		06/16/93
Total Metals			
Aluminum	20.3		06/11/93
Iron	20.2		06/10/93
Ferrous Iron	11.9		06/11/93
Ferric Iron	8.3		06/11/93
Manganese	3.90		06/10/93
Zinc	0.56		06/10/93

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22419
DATE: 06/23/93 dlf

WATER ANALYSIS

Centerville Wetlands
CWW2I-6-7, Cell II Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	638		06/10/93
Magnesium	156		06/10/93
Sulfate	2470		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	3910		06/09/93
Specific Conductance @ 25°C	3830	µmhos/cm	06/09/93
pH	3.5	s.u.	06/09/93
Total Acidity as $CaCO_3$	156		06/09/93
Nitrate plus Nitrite as N	<0.05		06/16/93
Total Metals			
Aluminum	13.7		06/11/93
Iron	14.5		06/10/93
Ferrous Iron	11.1		06/11/93
Ferric Iron	3.4		06/11/93
Manganese	5.40		06/10/93
Zinc	0.09		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22420
DATE: 06/23/93 dlf

WATER ANALYSIS

Centerville Wetlands
CWW3E-6-7, Cell III Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	569		06/10/93
Magnesium	171		06/10/93
Sulfate	2150		06/18/93
Total Alkalinity as $CaCO_3$	335		06/09/93
Total Dissolved Solids @ 180°C	4080		06/09/93
Specific Conductance @ 25°C	4280	µmhos/cm	06/09/93
pH	7.9	s.u.	06/09/93
Total Acidity as $CaCO_3$	24		06/09/93
Nitrate plus Nitrite as N	2.23		06/16/93
Total Metals			
Aluminum	0.6		06/11/93
Iron	7.40		06/10/93
Ferrous Iron	2.6		06/12/93
Ferric Iron	4.8		06/12/93
Manganese	6.83		06/10/93
Zinc	0.03		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22420 dup
DATE: 06/23/93 dlf

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Centerville Wetlands
CWW3E-6-7, Cell III Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	571		06/10/93
Magnesium	171		06/10/93
Sulfate	2140		06/18/93
Total Alkalinity as $CaCO_3$	335		06/11/93
Total Dissolved Solids @ 180°C	4090		06/09/93
Specific Conductance @ 25°C	4280	µmhos/cm	06/09/93
pH	7.8	s.u.	06/09/93
Total Acidity as $CaCO_3$	30		06/09/93
Nitrate plus Nitrite as N	2.18		06/16/93
Total Metals			
Aluminum	0.5		06/11/93
Iron	7.41		06/10/93
Ferrous Iron	2.6		06/12/93
Ferric Iron	4.8		06/12/93
Manganese	6.83		06/10/93
Zinc	0.03		06/10/93

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22421
DATE: 06/23/93 dlf

WATER ANALYSIS

Centerville Wetlands
CWWCB-6-7, Catchment Basin
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	328		06/14/93
Magnesium	117		06/14/93
Sulfate	2590		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	3880		06/09/93
Specific Conductance @ 25°C	3050	µmhos/cm	06/09/93
pH	3.4	s.u.	06/09/93
Total Acidity as $CaCO_3$	1430		06/09/93
Nitrate plus Nitrite as N	2.39		06/16/93
Total Metals			
Aluminum	199		06/11/93
Iron	2.56		06/10/93
Ferrous Iron	1.8		06/11/93
Ferric Iron	0.8		06/11/93
Manganese	3.48		06/10/93
Zinc	1.63		06/10/93

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Dept of State Lands
1625 11th Avenue
Helena, MT 59601

LAB NO: 93-22421 spi
DATE: 06/23/93 dlf

QUALITY ASSURANCE - SPIKED ANALYSIS

Centerville Wetlands
CWWCB-6-7, Catchment Basin
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	% Recovery	Date Analyzed
Calcium	96	06/14/93
Magnesium	95	06/14/93
Sulfate	101	06/18/93
Total Alkalinity as $CaCO_3$	N/A	N/A
Total Dissolved Solids @ 180°C	N/A	N/A
Specific Conductance @ 25°C	N/A	N/A
pH	N/A	N/A
Total Acidity as $CaCO_3$	N/A	N/A
Nitrate plus Nitrite as N	96	06/16/93
Total Metals		
Aluminum	99	06/11/93
Iron	99	06/10/93
Ferrous Iron	92	06/11/93
Ferric Iron	N/A	N/A
Manganese	103	06/10/93
Zinc	101	06/10/93

TABLE B.1 CENTERVILLE "C" WETLAND DATA

Sample Date	Sample Location	Flow (gpm)	pH (su)	EC (umhos/cm)	Temp. (Deg C)	TDS (mg/L)	SO4 (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	Fe (Total) (mg/L)	Fe (2+) (mg/L)	Fe (3+) (mg/L)	Mn (mg/L)	Zn (mg/L)	Al (mg/L)	Mg (mg/L)	Ca (mg/L)
10/02/92	CWW1I	NA	2.5	3710	NA	4130	2760	2400	0	288	2.30	268	1.77	2.88	241	94	201
10/02/92	CWW1e	NA	3.0	3500	NA	4020	2660	1480	0	115	34.80	80	3.6	2.96	181	123	417
10/02/92	CWW2e	NA	7.6	5300	NA	5040	2000	0	889	5	4.20	1	4.1	0.08	2.4	209	536
10/02/92	CWW3e	NA	7.7	5640	NA	5140	1750	0	1230	8	7.20	1	5.98	0.08	1.2	245	455
11/02/92	CWW1I	24.0	4.5	3190	6.7	3760	2450	353	0	85	33.40	52	1.71	2.11	59.9	92	742
11/02/92	CWW1I(ls)	NA	4.2	3210	NA	3820	2560	586	0	98	37.40	61	1.66	2.09	75.7	90	682
11/02/92	CWW1e	8.0	6.4	3360	4.8	3740	2250	0	241	17	11.70	5	2.51	1.37	2.2	103	758
11/02/92	CWW2e	6.0	7.6	4090	5.0	3860	1900	0	580	1	1.30	-0	3	0.03	0.1	136	561
11/02/92	CWW3e	NA	7.8	4290	4.8	3970	1880	0	748	4	4.30	0	4.85	0.02	0.1	155	495
04/05/93	CWW1I	NA	2.8	3290	NA	3910	2720	1800	0	100	9.00	91	2.78	1.95	NA	113	311
04/05/93	CWW1e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/05/93	CWW2e	NA	3.2	3400	NA	3490	2310	786	0	55	40.30	14	1.33	NA	NA	121	426
04/05/93	CWW3e	NA	8.8	4240	NA	3720	2130	40	392	19	11.30	8	11.8	0.04	NA	164	522
05/06/93	CWW1I	9.0	3.9	3280	15.2	3790	2700	918	0	147	11.10	136	2.54	2.1	223	107	542
05/06/93	CWW1e	5.0	3.3	3530	18.5	3800	2700	832	0	25	18.20	7	2.63	2.79	96.3	101	616
05/06/93	CWW2e	15.0	3.3	3790	19.0	3810	2680	355	0	9	4.20	5	4.84	0.96	38.8	140	719
05/06/93	CWW3e	14.0	4.0	3740	20.1	3860	2540	281	0	4	3.00	1	5.76	1.77	42.6	133	680
06/07/93	CWW1I	3.9	3.5	3020	13.5	3820	2530	1220	0	160	4.30	156	3.38	1.73	198	117	391
06/07/93	CWW1e	3.6	3.3	3520	13.7	3630	2350	223	0	20	11.90	8	3.9	0.56	20.3	124	612
06/07/93	CWW2e	4.8	3.5	3830	13.7	3910	2470	156	0	15	11.10	3	5.4	0.09	13.7	156	638
06/07/93	CWW3e	7.2	7.9	4280	14.9	4080	2150	24	335	7	2.60	5	8.83	0.03	0.6	171	569
07/08/93	CWW1I	2.3	2.7	3750	13.2	5020	3150	2220	0	58	0.80	57	2.54	2.84	263	95	229
07/08/93	CWW1e	7.0	2.9	3340	15.4	4260	2650	1730	0	180	80.30	100	2.12	2.38	206	85	257
07/08/93	CWW2e	5.5	4.2	3400	16.2	3470	2290	245	0	2	2.10	0	4.51	0.25	39.6	128	547
07/08/93	CWW3e	11.0	4.4	3270	15.5	3280	2150	258	0	5	4.60	0	4.55	0.18	18.7	124	542

CWW1I = Cell 1 Influent; CWW1I(ls) = Cell 1 Influent from ALD; CWW1e = Cell 1effluent; CWW2e = Cell 2 effluent; CWW3e = Cell 3 effluent.

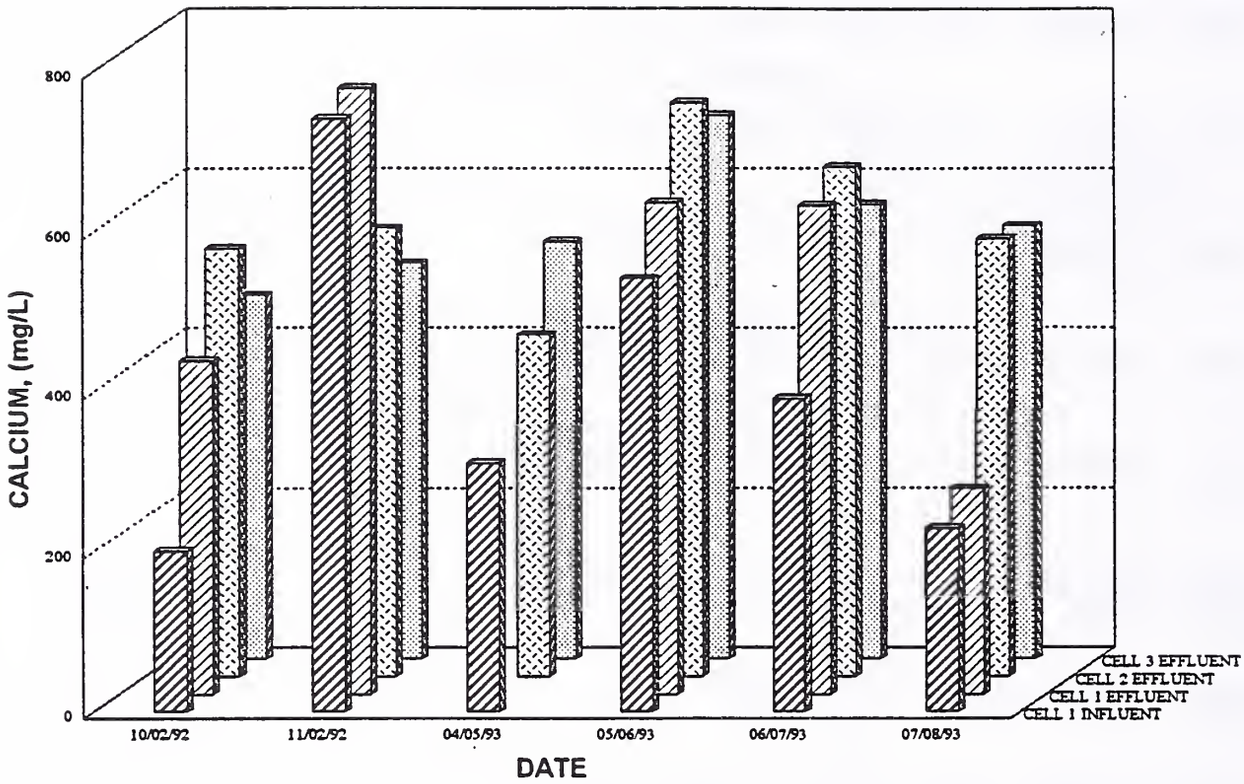

Figure B.1 Calcium analyses at the Centerville "C" Wetland since start-up.

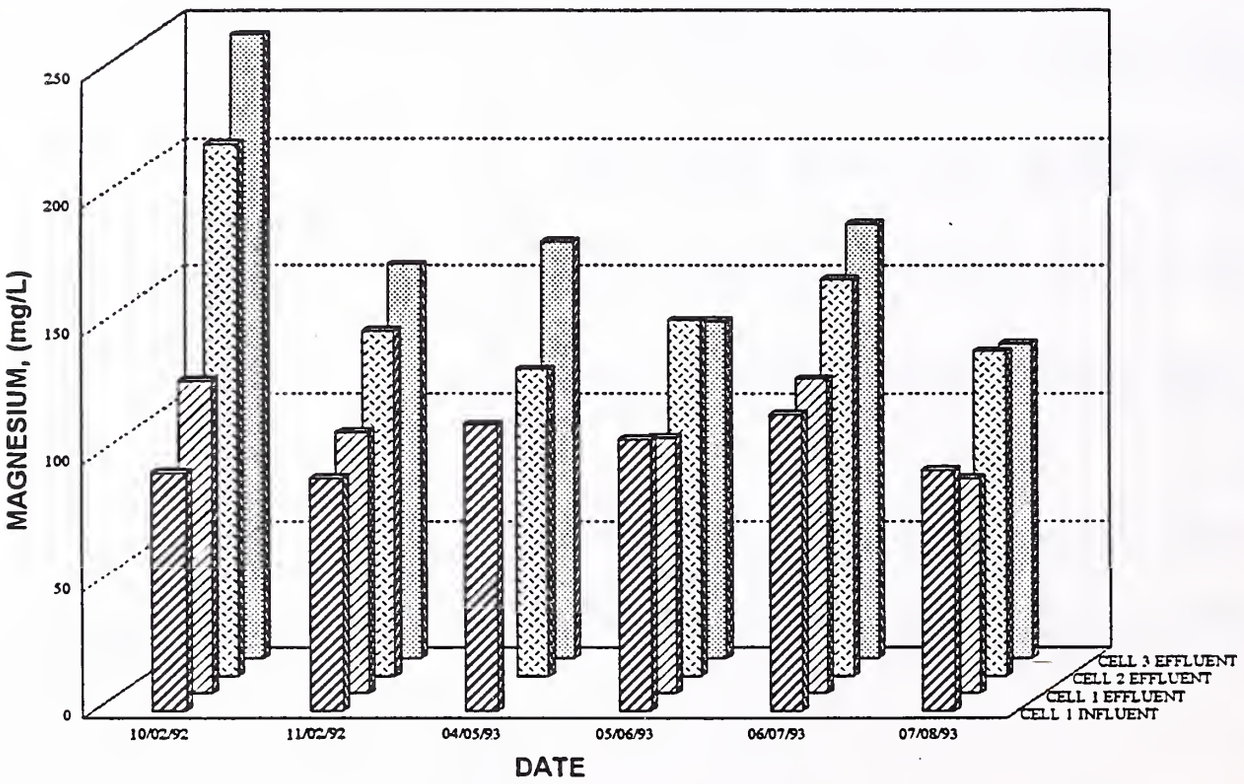

Figure B.2 Magnesium analyses at the Centerville "C" Wetland since start-up.

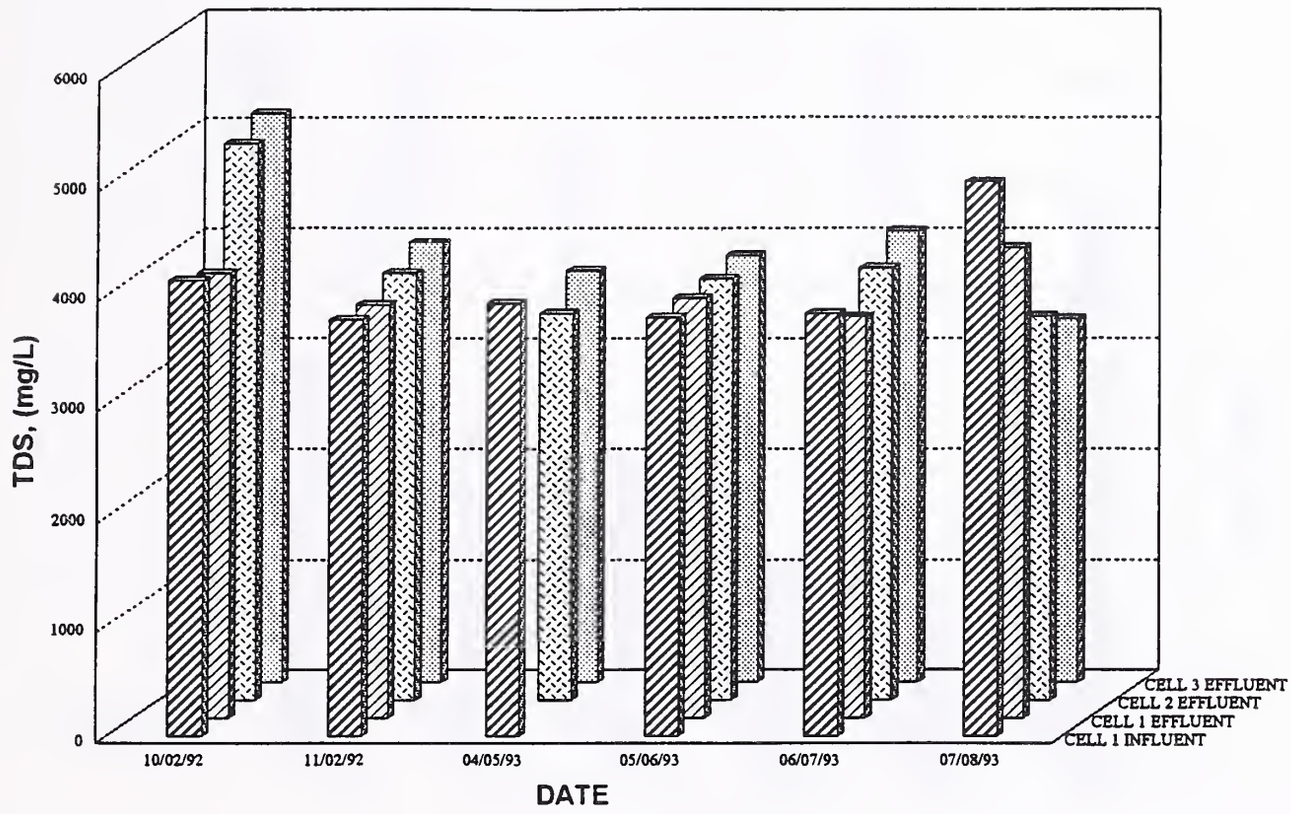

Figure B.3 TDS analyses at the Centerville "C" Wetland since start-up.

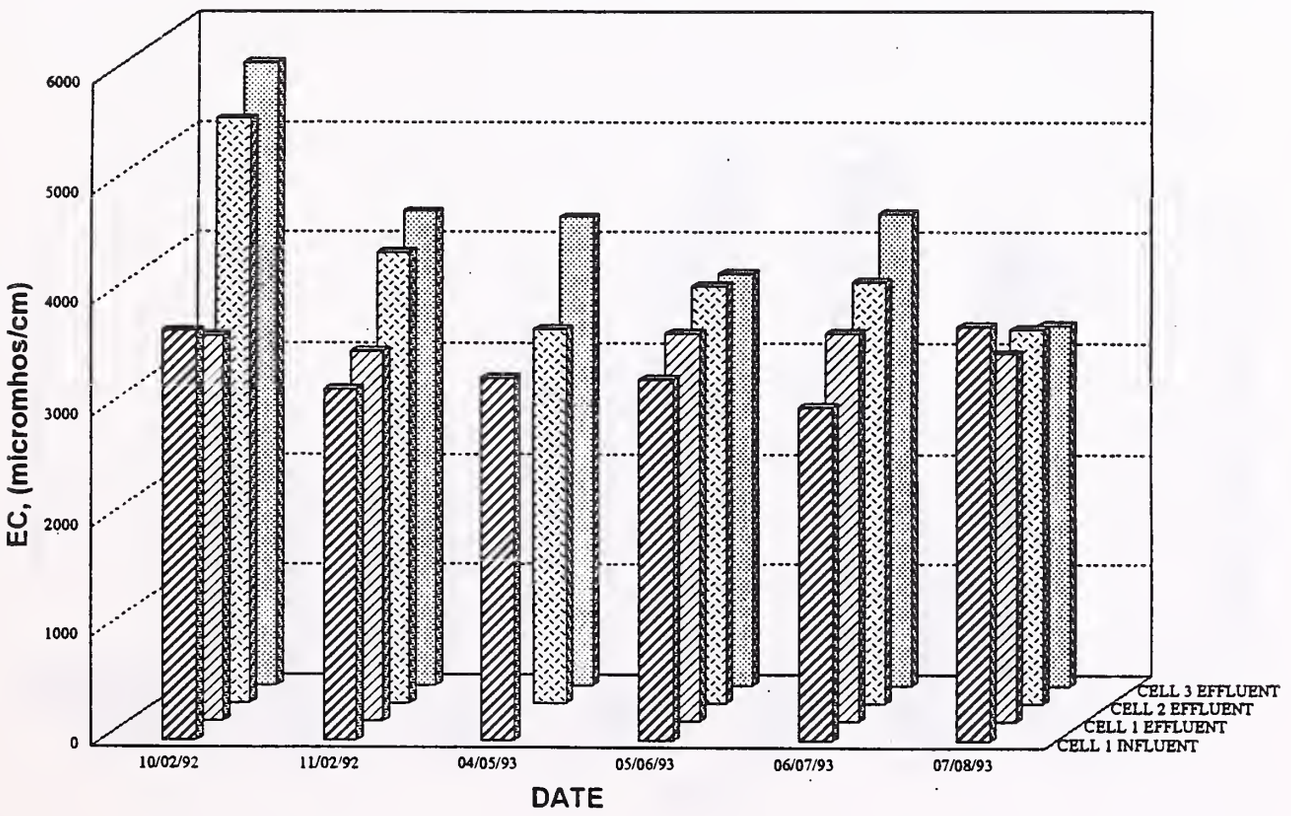

Figure B.4 EC of waters at the Centerville "C" Wetland since start-up.

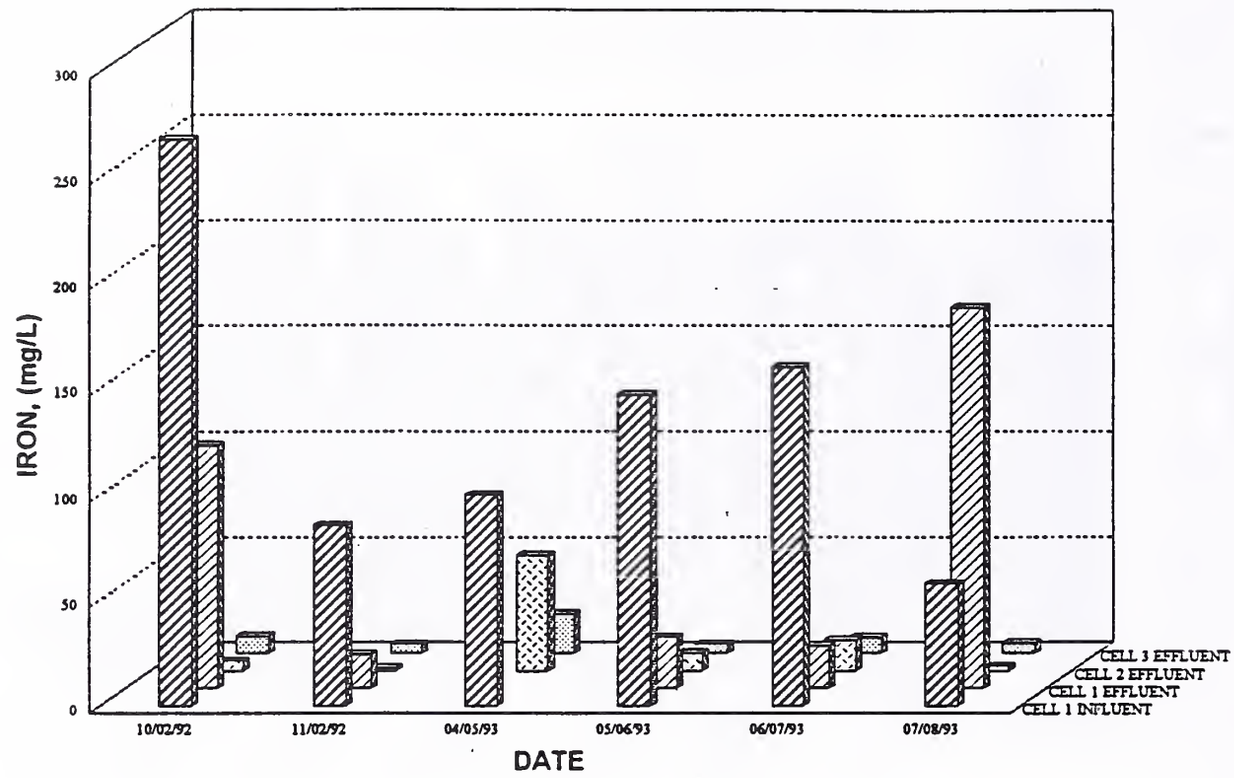

Figure B.5 Iron analyses at the Centerville "C" Wetland since start-up.

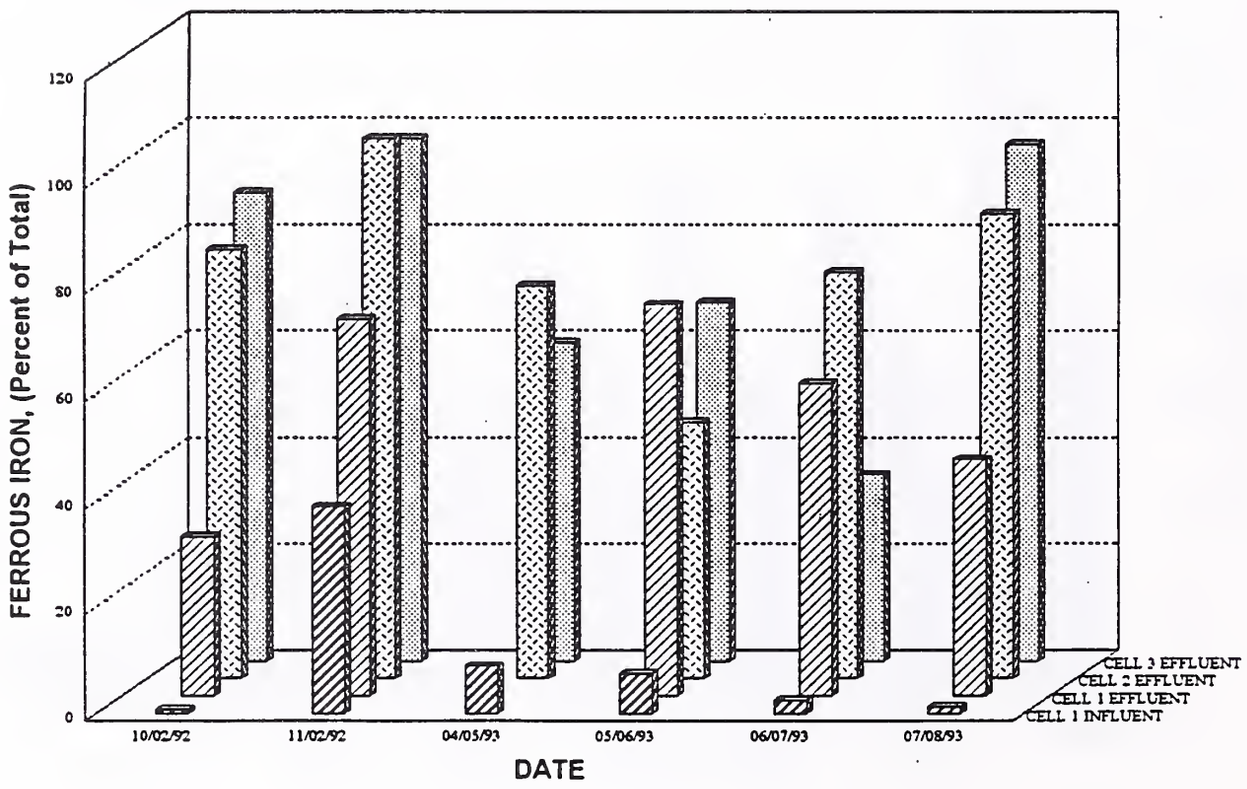

Figure B.6 Ferrous iron as a percent of total at the Centerville "C" Wetland.

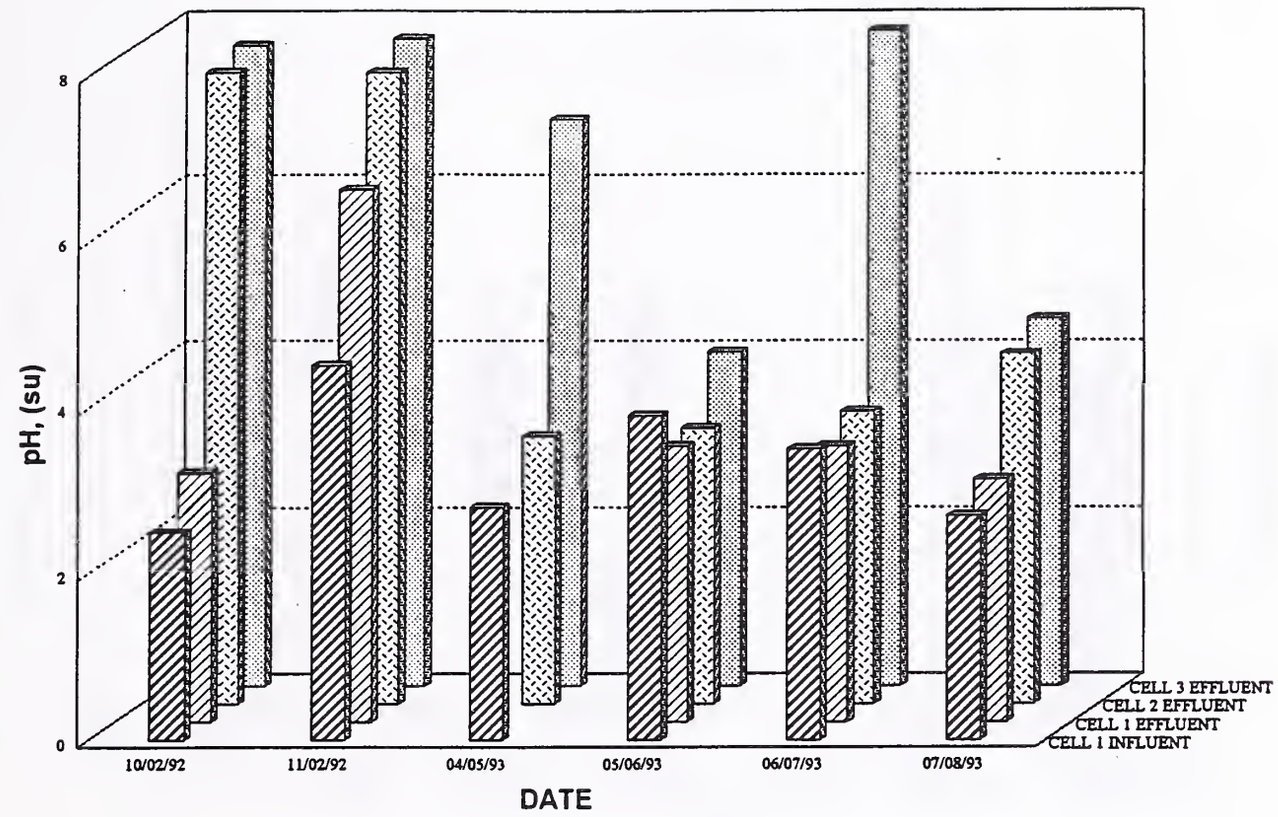

Figure B.7 pH measurements at the Centerville "C" Wetland since start-up.

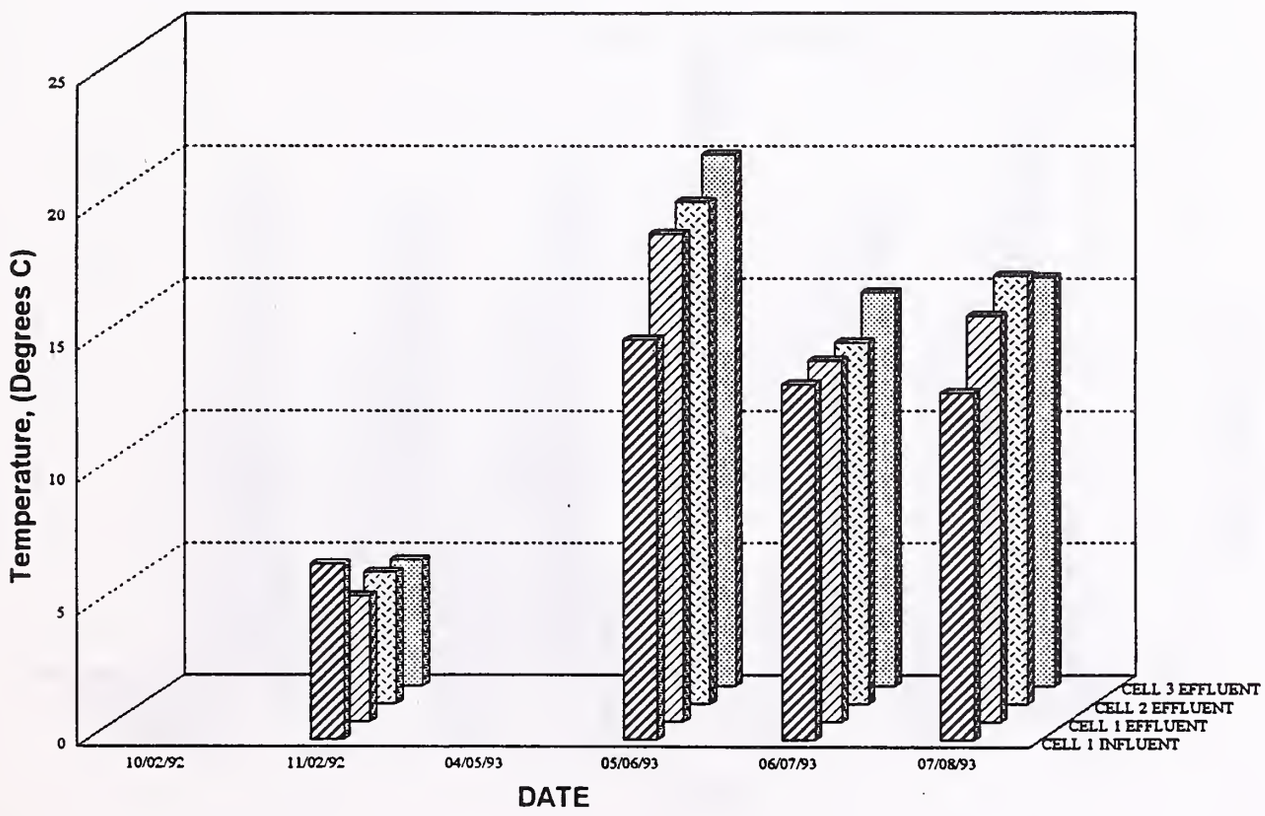

Figure B.8 Temperature measurements at the Centerville "C" Wetland since start-up.

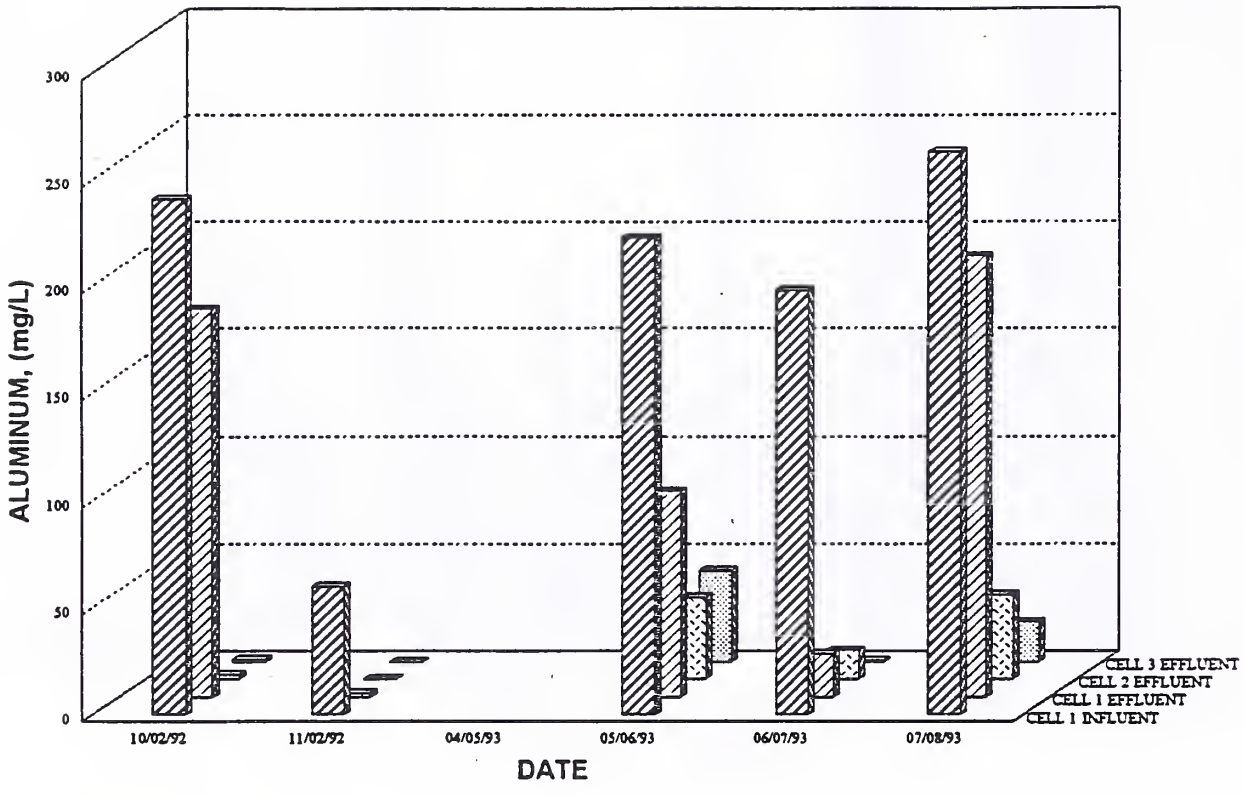

Figure B.9 Aluminum analyses at the Centerville "C" Wetland since start-up.

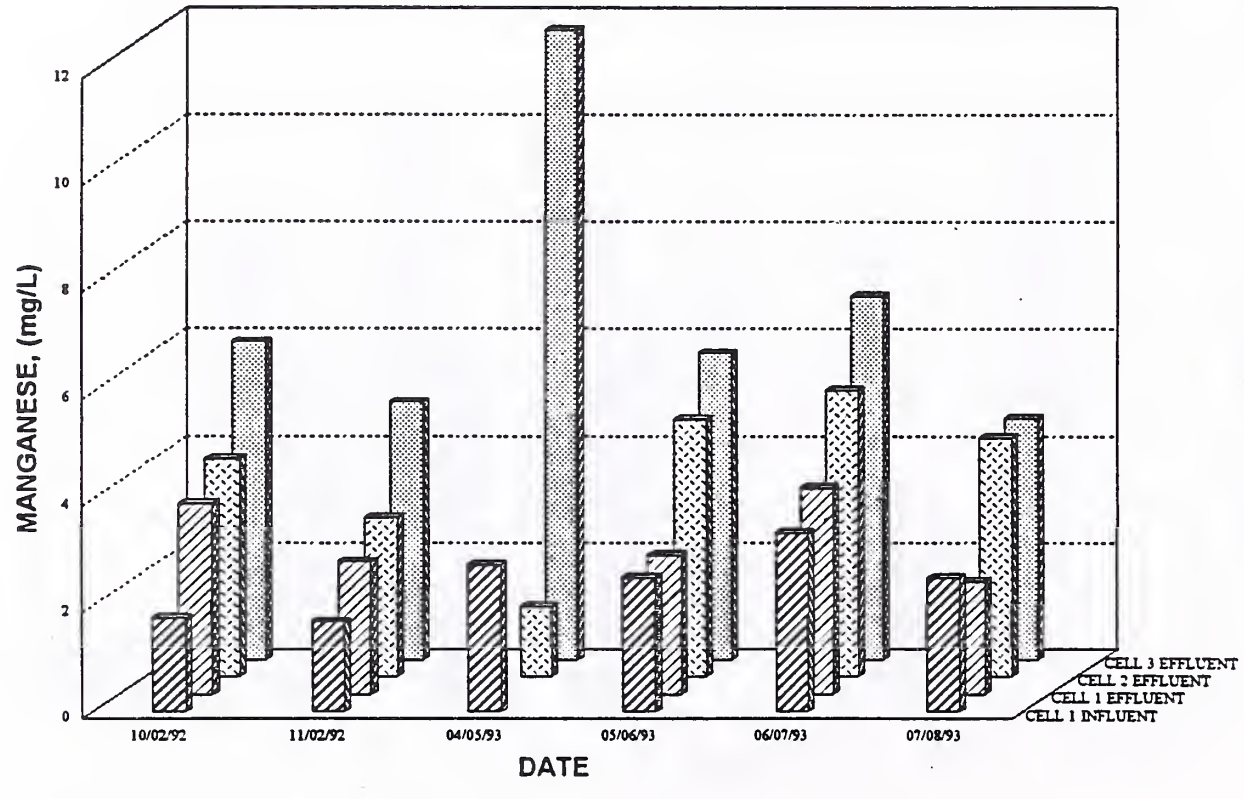

Figure B.10 Manganese analyses at the Centerville "C" Wetland since start-up.

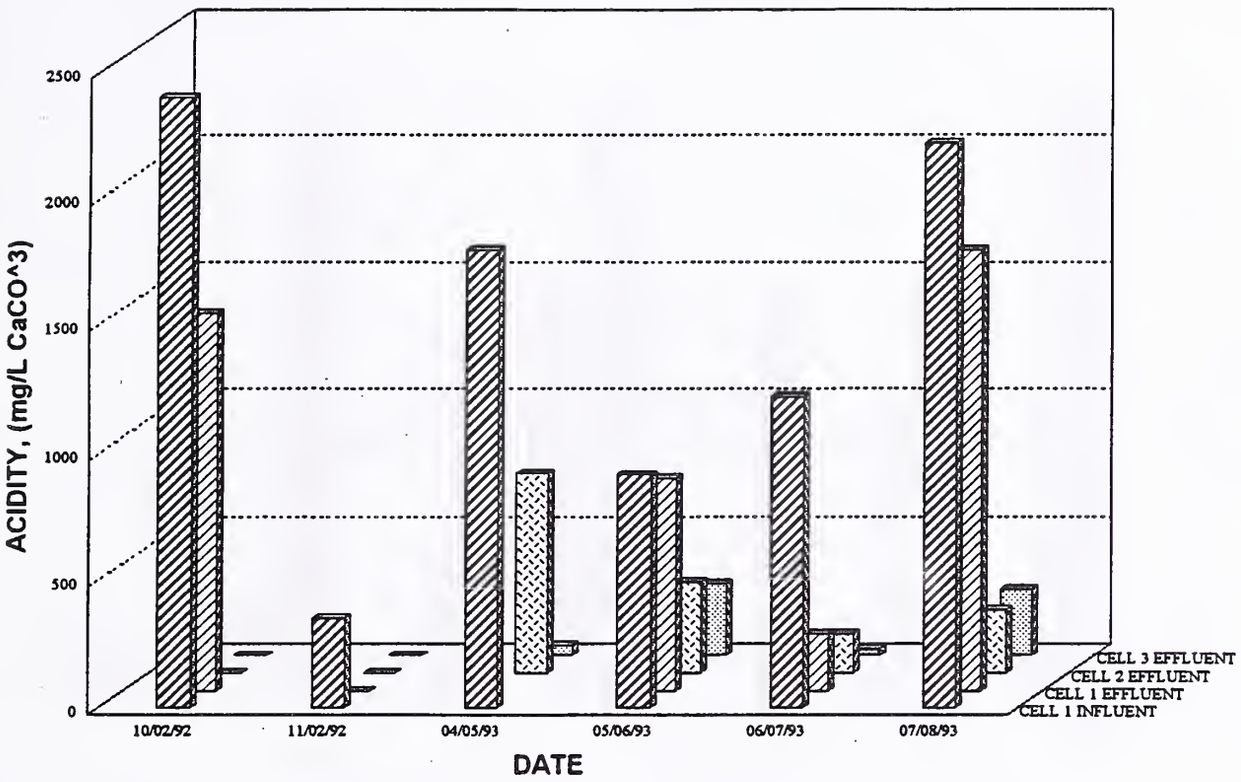

Figure B.11 Acidity analyses at the Centerville "C" Wetland since start-up.

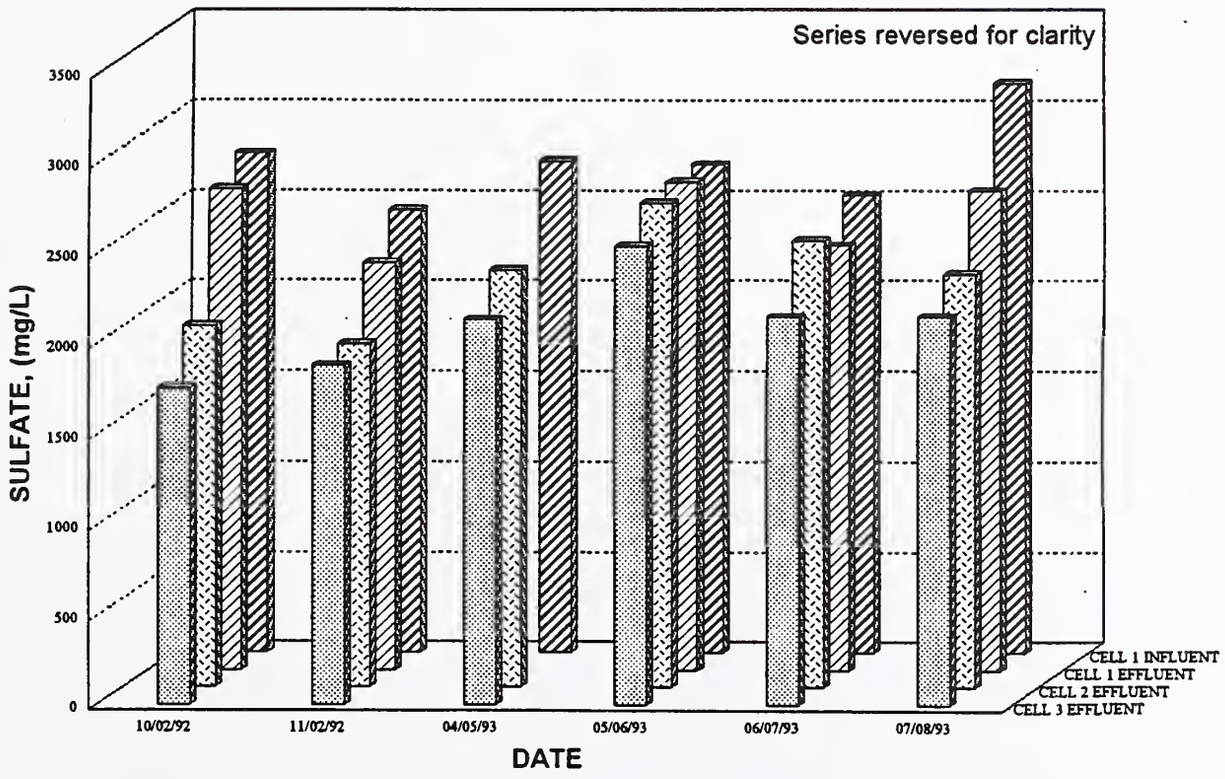

Figure B.12 Sulfate analyses at the Centerville "C" Wetland since start-up.

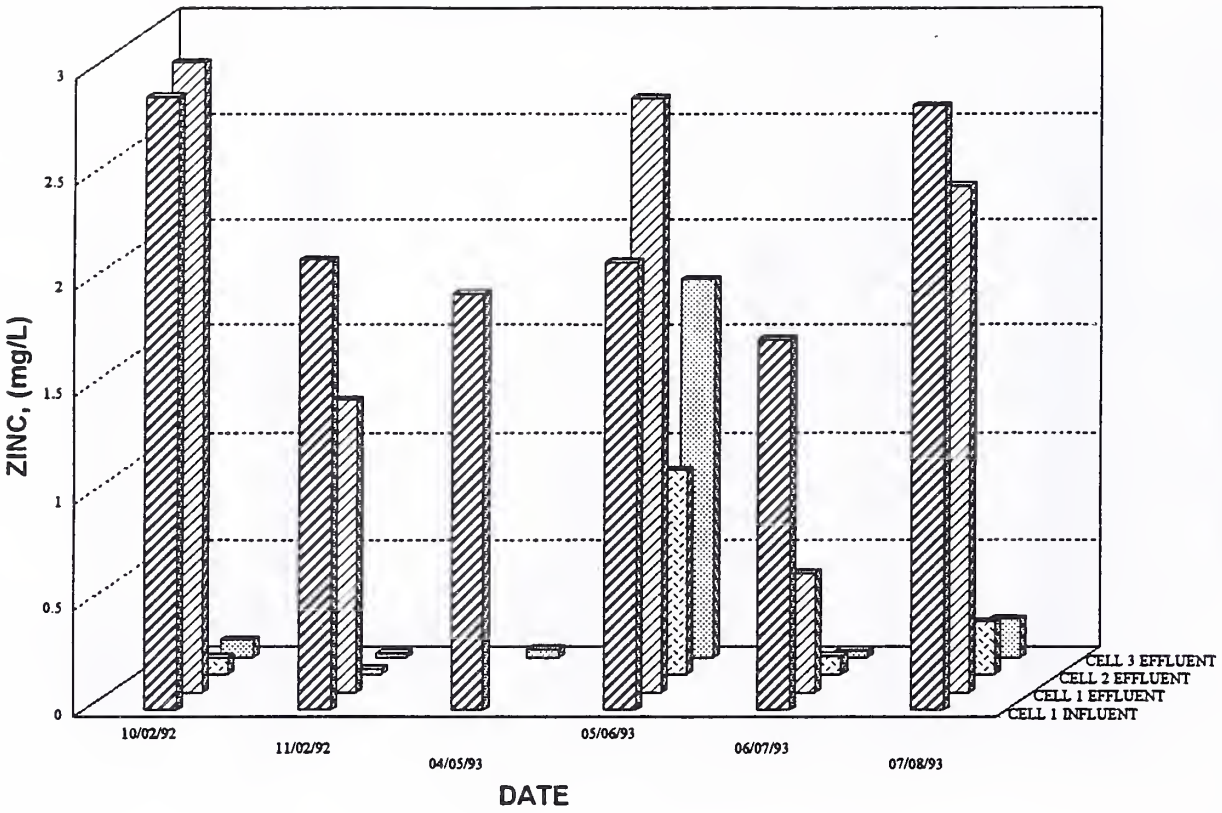

Figure B.13 Zinc analyses at the Centerville "C" Wetland since start-up.

APPENDIX C

Stockett SE Wetland
Data Tables, Charts and Laboratory Reports

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1107 SOUTH BROADWAY • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36383
DATE: 09/30/92 crp

WATER ANALYSIS

Stockett Wetlands NE
North Effluent, SWWNE
Sampled 09/03/92 @ 1400
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	20800	
Total Acidity as $CaCO_3$	12000	
Calcium	495	
Magnesium	455	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	10100	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	1250	
Iron	1810	
Ferrous Iron	1360	
Ferric Iron	450	
Manganese	12.6	
Zinc	80.2	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36384
DATE: 09/30/92 crp

WATER ANALYSIS

Stockett Wetlands NE
South Influent, SWWSI
Sampled 09/03/92 @ 1400
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	17800	
Total Acidity as $CaCO_3$	10500	
Calcium	429	
Magnesium	282	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	8550	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	1140	
Iron	1460	
Ferrous Iron	949	
Ferric Iron	511	
Manganese	8.13	
Zinc	80.0	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36385
DATE: 09/30/92 crp

WATER ANALYSIS

Stockett Wetlands NE
South Effluent, SWWSE
Sampled 09/03/92 @ 1430
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	18900	
Total Acidity as $CaCO_3$	11000	
Calcium	494	
Magnesium	324	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	9020	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	1220	
Iron	1290	
Ferrous Iron	730	
Ferric Iron	560	
Manganese	13.6	
Zinc	91.9	

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TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36386
DATE: 09/30/92 crp

WATER ANALYSIS

Stockett Wetlands NE
Out Flow Effluent, SWWOE
Sampled 09/03/92 @ 1430
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	19400	
Total Acidity as $CaCO_3$	11400	
Calcium	482	
Magnesium	388	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	9320	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	1280	
Iron	1340	
Ferrous Iron	736	
Ferric Iron	604	
Manganese	14.6	
Zinc	76.3	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59620

LAB NO.: 92-36382
DATE: 09/30/92 crp

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WATER ANALYSIS

Stockett Wetlands NE
North Influent, SWWNI
Sampled 09/03/92 @ 1400
Submitted 09/04/92

Constituent	mg/l (ppm)	
Total Dissolved Solids @ 180°C	21000	
Total Acidity as $CaCO_3$	12800	
Calcium	439	
Magnesium	256	
Total Alkalinity as $CaCO_3$	0	
Specific Conductance @ 25°C	9640	µmhos/cm
pH	2.4	s.u.
Dissolved Metals		
Aluminum	1460	
Iron	1780	
Ferrous Iron	1230	
Ferric Iron	550	
Manganese	5.83	
Zinc	77.7	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39243
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
S. Wetland Influent, SWWSI-10-1LMS
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	6.1	s.u.
Specific Conductance @ 25°C	5790	µmhos/cm
Total Acidity as $CaCO_3$	0	
Total Alkalinity as $CaCO_3$	701	
Total Dissolved Solids @ 180°C	6860	
Magnesium	353	
Calcium	942	
Sulfate	3320	
Nitrate plus Nitrite as N	1.15	
Ferrous Iron	572	
Ferric Iron	24	
Dissolved Metals		
Aluminum	8.1	
Iron	596	
Manganese	33.3	
Zinc	19.3	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39244
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
S. Wetland Influent, SWWSI-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.7	s.u.
Specific Conductance @ 25°C	9080	µmhos/cm
Total Acidity as $CaCO_3$	11400	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	18000	
Magnesium	290	
Calcium	447	
Sulfate	10200	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	1080	
Ferric Iron	480	
Dissolved Metals		
Aluminum	1190	
Iron	1560	
Manganese	6.93	
Zinc	65.0	

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TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39245
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
S. Wetland Effluent, SWWSE-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	8110	µmhos/cm
Total Acidity as $CaCO_3$	6720	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	13400	
Magnesium	432	
Calcium	829	
Sulfate	8300	
Nitrate plus Nitrite as N	0.89	
Ferrous Iron	262	
Ferric Iron	371	
Dissolved Metals		
Aluminum	594	
Iron	633	
Manganese	26.6	
Zinc	41.7	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39246
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
N. Wetland Influent, SWWNI-10-1LMS
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	9590	µmhos/cm
Total Acidity as $CaCO_3$	14300	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	21500	
Magnesium	247	
Calcium	440	
Sulfate	11300	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	945	
Ferric Iron	855	
Dissolved Metals		
Aluminum	1490	
Iron	1800	
Manganese	5.81	
Zinc	76.2	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39247
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
N. Wetland Influent, SWWNI-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	9550	µmhos/cm
Total Acidity as $CaCO_3$	13000	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	21300	
Magnesium	253	
Calcium	449	
Sulfate	11200	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	939	
Ferric Iron	861	
Dissolved Metals		
Aluminum	1460	
Iron	1800	
Manganese	5.62	
Zinc	76.3	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39248
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
N. Wetland Effluent, SWWNE-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.5	s.u.
Specific Conductance @ 25°C	10600	µmhos/cm
Total Acidity as $CaCO_3$	14100	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	21100	
Magnesium	500	
Calcium	490	
Sulfate	13600	
Nitrate plus Nitrite as N	0.08	
Ferrous Iron	1410	
Ferric Iron	660	
Dissolved Metals		
Aluminum	1260	
Iron	2070	
Manganese	13.3	
Zinc	81.4	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39249
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
Combined Wetland Outflow Effluent, SWWOE-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.7	s.u.
Specific Conductance @ 25°C	9070	µmhos/cm
Total Acidity as $CaCO_3$	10200	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	16500	
Magnesium	465	
Calcium	709	
Sulfate	9900	
Nitrate plus Nitrite as N	0.54	
Ferrous Iron	694	
Ferric Iron	606	
Dissolved Metals		
Aluminum	937	
Iron	1300	
Manganese	21.3	
Zinc	62.2	

ENERGY LABORATORIES

Abandoned MINE and Reclamation Bureau
Helena, MT 59620

USC-AMRB
444-2074

CHAIN OF CUSTODY RECORD

PROJ. NO.	PROJECT NAME
	Belt Wetland

SAMPLERS: *(Signature)* Earl McCurley Earl McCurley

STAT. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS
CELL I	10/2				CELL INFLUENT I BWWI1-10-2	3
				✓	HCl	
				✓	HNO_3	
				✓	NONE	
CELL I effluent	10/2			✓	CELL I ~~Inf~~ Effluent BWWE1-10-2	3
					HCl	
					HNO_3	
					NONE	
CELL II effluent	10/2			✓	CELL II effluent BWWZE-10-2	3
					HCl	
					HNO_3	
					None	
CELL III effluent	10/2			✓	CELL III effluent BWW3E-10-2	3
					HCl, None, HNO_3	

REMARKS: Belt wetland H_2O samps (French Coulee)

Ph, SC, Acidity, Alkalinity, Tds, Mn, Mg, AL, Fe, CA, Zn, Ferric + Ferrous Iron, ~~Sulfate (SO4)~~ Sulfate, Nitrate?

all samples Taken ~~at~~ between 11:00 – 2:30 PM 10/2/92

Relinquished *(Signature)*	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*
Earl McCurley	10-2-92 4:00PM				
Relinquished (Signature)	Date/Time	Received by: *(Signature)*	Relinquished by: *(Signature)*	Date/Time	Received by: *(Signature)*
Relinquished (Signature)	Date/Time	Received for Laboratory by: *(Signature)* Kim Stevenson	Date/Time 10/05/92 0856	Remarks	

Split Samples:
[] Accepted [] Declined

Signature

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39243
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
S. Wetland Influent, SWWSI-10-1LMS
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	6.1	s.u.
Specific Conductance @ 25°C	5790	µmhos/cm
Total Acidity as $CaCO_3$	0	
Total Alkalinity as $CaCO_3$	701	
Total Dissolved Solids @ 180°C	6860	
Magnesium	353	
Calcium	942	
Sulfate	3320	
Nitrate plus Nitrite as N	1.15	
Ferrous Iron	572	
Ferric Iron	24	
Dissolved Metals		
Aluminum	8.1	
Iron	596	
Manganese	33.3	
Zinc	19.3	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39244
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
S. Wetland Influent, SWWSI-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.7	s.u.
Specific Conductance @ 25°C	9080	µmhos/cm
Total Acidity as $CaCO_3$	11400	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	18000	
Magnesium	290	
Calcium	447	
Sulfate	10200	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	1080	
Ferric Iron	480	
Dissolved Metals		
Aluminum	1190	
Iron	1560	
Manganese	6.93	
Zinc	65.0	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39245
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
S. Wetland Effluent, SWWSE-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	8110	µmhos/cm
Total Acidity as $CaCO_3$	6720	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	13400	
Magnesium	432	
Calcium	829	
Sulfate	8300	
Nitrate plus Nitrite as N	0.89	
Ferrous Iron	262	
Ferric Iron	371	
Dissolved Metals		
Aluminum	594	
Iron	633	
Manganese	26.6	
Zinc	41.7	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39246
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
N. Wetland Influent, SWWNI-10-1LMS
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	9590	µmhos/cm
Total Acidity as $CaCO_3$	14300	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	21500	
Magnesium	247	
Calcium	440	
Sulfate	11300	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	945	
Ferric Iron	855	
Dissolved Metals		
Aluminum	1490	
Iron	1800	
Manganese	5.81	
Zinc	76.2	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39247
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
N. Wetland Influent, SWWNI-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.6	s.u.
Specific Conductance @ 25°C	9550	µmhos/cm
Total Acidity as $CaCO_3$	13000	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	21300	
Magnesium	253	
Calcium	449	
Sulfate	11200	
Nitrate plus Nitrite as N	<0.05	
Ferrous Iron	939	
Ferric Iron	861	
Dissolved Metals		
Aluminum	1460	
Iron	1800	
Manganese	5.62	
Zinc	76.3	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39248
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
N. Wetland Effluent, SWWNE-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.5	s.u.
Specific Conductance @ 25°C	10600	µmhos/cm
Total Acidity as $CaCO_3$	14100	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	21100	
Magnesium	500	
Calcium	490	
Sulfate	13600	
Nitrate plus Nitrite as N	0.08	
Ferrous Iron	1410	
Ferric Iron	660	
Dissolved Metals		
Aluminum	1260	
Iron	2070	
Manganese	13.3	
Zinc	81.4	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
Abandoned Mine & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-39249
DATE: 10/15/92 crp

WATER ANALYSIS

Stockett NE Wetlands
Combined Wetland Outflow Effluent, SWWOE-10-1
Sampled 10/02/92
Submitted 10/05/92

Constituent	mg/l (ppm)	
pH	2.7	s.u.
Specific Conductance @ 25°C	9070	µmhos/cm
Total Acidity as $CaCO_3$	10200	
Total Alkalinity as $CaCO_3$	0	
Total Dissolved Solids @ 180°C	16500	
Magnesium	465	
Calcium	709	
Sulfate	9900	
Nitrate plus Nitrite as N	0.54	
Ferrous Iron	694	
Ferric Iron	606	
Dissolved Metals		
Aluminum	937	
Iron	1300	
Manganese	21.3	
Zinc	62.2	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45484
DATE: 11/17/92 da

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WATER ANALYSIS

Stockett Wetlands
SWWSI-11-2
South Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	425	
Magnesium	272	
Sulfate	10400	
Total Dissolved Solids @ 180° C	18400	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	10900	
Specific Conductance @ 25° C	8800	µmhos/cm
pH	2.9	s.u.
Nitrate plus Nitrite as N	0.14	

Total Metals

Aluminum	1250
Iron	1780
Ferrous Iron	944
Ferric Iron	836
Manganese	7.74
Zinc	78.6

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45485
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWSI-11-2LMS
South Influent Limestone Trench
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	597	
Magnesium	304	
Sulfate	4590	
Total Dissolved Solids @ 180° C	8400	
Total Alkalinity as $CaCO_3$	508	
Total Acidity as $CaCO_3$	1230	
Specific Conductance @ 25° C	6290	µmhos/cm
pH	5.8	s.u.
Nitrate plus Nitrite as N	0.13	

Total Metals

Aluminum	17.6	
Iron	1310	
Ferrous Iron	966	
Ferric Iron	344	
Manganese	9.96	
Zinc	74.1	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45486
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWSE-11-2
South Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	593	
Magnesium	299	
Sulfate	4380	
Total Dissolved Solids @ 180° C	7530	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	1730	
Specific Conductance @ 25° C	5270	µmhos/cm
pH	4.1	s.u.
Nitrate plus Nitrite as N	0.11	

Total Metals

Aluminum	5.6	
Iron	917	
Ferrous Iron	587	
Ferric Iron	330	
Manganese	10.3	
Zinc	65.7	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45487
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWNI-11-2
North Influent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	449	
Magnesium	274	
Sulfate	9540	
Total Dissolved Solids @ 180° C	16100	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	9380	
Specific Conductance @ 25° C	8580	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.14	

Total Metals

Aluminum	1000
Iron	2160
Ferrous Iron	1070
Ferric Iron	1090
Manganese	8.63
Zinc	75.4

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45488
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWNI-11-2LMS
North Influent Limestone Trench
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	415	
Magnesium	240	
Sulfate	11200	
Total Dissolved Solids @ 180° C	20700	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	12600	
Specific Conductance @ 25° C	9270	µmhos/cm
pH	2.7	s.u.
Nitrate plus Nitrite as N	0.15	

Total Metals

Aluminum	1380	
Iron	2040	
Ferrous Iron	749	
Ferric Iron	1290	
Manganese	7.02	
Zinc	89.5	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45490
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWNMD-11-2
Middle Influent (North)
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	414	
Magnesium	510	
Sulfate	9710	
Total Dissolved Solids @ 180° C	16800	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	8230	
Specific Conductance @ 25° C	9040	µmhos/cm
pH	3.6	s.u.
Nitrate plus Nitrite as N	0.07	

Total Metals

Aluminum	568	
Iron	2900	
Ferrous Iron	2240	
Ferric Iron	660	
Manganese	13.0	
Zinc	65.4	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45490 dup
DATE: 11/17/92 da

QUALITY ASSURANCE-DUPLICATE ANALYSIS

Stockett Wetlands
SWWNMD-11-2
Middle Influent (North)
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	417	
Magnesium	515	
Sulfate	9690	
Total Dissolved Solids @ 180° C	16800	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	8000	
Specific Conductance @ 25° C	9080	µmhos/cm
pH	3.6	s.u.
Nitrate plus Nitrite as N	0.07	

Total Metals

Aluminum	555	
Iron	2840	
Ferrous Iron	2240	
Ferric Iron	600	
Manganese	12.7	
Zinc	63.8	

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45489
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWNE-11-2
North Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	423	
Magnesium	392	
Sulfate	9880	
Total Dissolved Solids @ 180° C	17200	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	9820	
Specific Conductance @ 25° C	8960	µmhos/cm
pH	2.8	s.u.
Nitrate plus Nitrite as N	0.70	

Total Metals

Aluminum	987	
Iron	2030	
Ferrous Iron	1160	
Ferric Iron	870	
Manganese	11.9	
Zinc	77.3	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45491
DATE: 11/17/92 da

WATER ANALYSIS

Stockett Wetlands
SWWOE-11-2
Outflow Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	mg/l (ppm)	
Calcium	554	
Magnesium	342	
Sulfate	6810	
Total Dissolved Solids @ 180° C	11500	
Total Alkalinity as $CaCO_3$	0	
Total Acidity as $CaCO_3$	5460	
Specific Conductance @ 25° C	7060	µmhos/cm
pH	2.9	s.u.
Nitrate plus Nitrite as N	0.41	

Total Metals

Aluminum	471	
Iron	1230	
Ferrous Iron	679	
Ferric Iron	551	
Manganese	11.4	
Zinc	60.4	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Department of State Lands
Abandoned Mines & Reclamation Bureau
Capitol Station
Helena, MT 59620

LAB NO.: 92-45491 spi
DATE: 11/17/92 da

QUALITY ASSURANCE-SPIKED ANALYSIS

Stockett Wetlands
SWWOE-11-2
Outflow Effluent
Sampled 11/02/92
Submitted 11/03/92

Constituent	% Recovery	
Calcium	97	
Magnesium	98	
Sulfate	99	
Total Dissolved Solids @ 180° C	N/A	
Total Alkalinity as $CaCO_3$	N/A	
Total Acidity as $CaCO_3$	N/A	
Specific Conductance @ 25° C	N/A	µmhos/cm
pH	N/A	s.u.
Nitrate plus Nitrite as N	98	
Total Metals		
Aluminum	99	
Iron	99	
Ferrous Iron	89	
Ferric Iron	N/A	
Manganese	99	
Zinc	100	

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12955
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
South Influent, SWWSI-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	430		04/13/93
Magnesium	276		04/13/93
Sulfate	11100		04/12/93
Total Dissolved Solids @ 180°C	16600		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	9910		04/08/93
Specific Conductance @ 25°C	8670	µmhos/cm	04/07/93
pH	2.8	s.u.	04/07/93
Nitrate plus Nitrite as N	0.36		04/09/93
Total Metals			
Iron	1230		04/06/93
Ferric Iron	320		04/07/93
Ferrous Iron	910		04/07/93
Manganese	8.21		04/08/93
Zinc	65.2		04/08/93
Aluminum	1210		04/08/93

ENERGY LABORATORIES, INC.
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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12956
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
South Effluent, SWWSE-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	438		04/13/93
Magnesium	287		04/13/93
Sulfate	7930		04/12/93
Total Dissolved Solids @ 180°C	12600		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	6540		04/08/93
Specific Conductance @ 25°C	6850	µmhos/cm	04/07/93
pH	3.0	s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05		04/09/93
Total Metals			
Iron	396		04/06/93
Ferric Iron	17.0		04/07/93
Ferrous Iron	379		04/07/93
Manganese	8.04		04/08/93
Zinc	57.4		04/08/93
Aluminum	886		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12957
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
North Influent, SWWNI-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	462		04/13/93
Magnesium	266		04/13/93
Sulfate	10900		04/12/93
Total Dissolved Solids @ 180°C	17500		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	9760		04/08/93
Specific Conductance @ 25°C	8990	µmhos/cm	04/07/93
pH	2.8	s.u.	04/07/93
Nitrate plus Nitrite as N	1.12		04/09/93
Total Metals			
Iron	1580		04/06/93
Ferric Iron	510		04/07/93
Ferrous Iron	1070		04/07/93
Manganese	7.22		04/08/93
Zinc	75.7		04/08/93
Aluminum	1180		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12958
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
North Effluent, SWWNE-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	408		04/13/93
Magnesium	305		04/13/93
Sulfate	8810		04/12/93
Total Dissolved Solids @ 180°C	13700		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	7460		04/08/93
Specific Conductance @ 25°C	7580	µmhos/cm	04/07/93
pH	2.8	s.u.	04/07/93
Nitrate plus Nitrite as N	0.71		04/09/93
Total Metals			
Iron	1120		04/06/93
Ferric Iron	379		04/07/93
Ferrous Iron	741		04/07/93
Manganese	8.43		04/08/93
Zinc	59.0		04/08/93
Aluminum	842		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12959
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
Outflow Effluent, SWWOE-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	436		04/13/93
Magnesium	313		04/13/93
Sulfate	8130		04/12/93
Total Dissolved Solids @ 180°C	12700		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	6810		04/08/93
Specific Conductance @ 25°C	7080	µmhos/cm	04/07/93
pH	2.7	s.u.	04/07/93
Nitrate plus Nitrite as N	0.57		04/09/93
Total Metals			
Iron	500		04/06/93
Ferric Iron	186		04/07/93
Ferrous Iron	314		04/07/93
Manganese	10.8		04/08/93
Zinc	53.4		04/08/93
Aluminum	809		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12960
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
South Influent Limestone Trench, SWWSI-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	930		04/13/93
Magnesium	588		04/13/93
Sulfate	9130		04/12/93
Total Dissolved Solids @ 180°C	14800		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	8000		04/08/93
Specific Conductance @ 25°C	7680	µmhos/cm	04/07/93
pH	3.8	s.u.	04/07/93
Nitrate plus Nitrite as N	0.09		04/09/93
Total Metals			
Iron	1140		04/06/93
Ferric Iron	130		04/07/93
Ferrous Iron	1010		04/07/93
Manganese	8.24		04/08/93
Zinc	71.4		04/08/93
Aluminum	1110		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12960 dup
DATE: 04/15/93 ag

QUALITY ASSURANCE - DUPLICATE ANALYSIS

Stockett Wetlands
South Influent Limestone Trench, SWWSI-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	934		04/13/93
Magnesium	591		04/13/93
Sulfate	9420		04/12/93
Total Dissolved Solids @ 180°C	14800		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	8220		04/08/93
Specific Conductance @ 25°C	7680	µmhos/cm	04/07/93
pH	3.8	s.u.	04/07/93
Nitrate plus Nitrite as N	0.09		04/09/93
Total Metals			
Iron	1140		04/06/93
Ferric Iron	130		04/07/93
Ferrous Iron	1010		04/07/93
Manganese	8.29		04/08/93
Zinc	71.6		04/08/93
Aluminum	1110		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12961
DATE: 04/15/93 ag

WATER ANALYSIS

Stockett Wetlands
North Middle Discharge, SWWND-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	809		04/13/93
Magnesium	1010		04/13/93
Sulfate	10100		04/12/93
Total Dissolved Solids @ 180°C	17100		04/07/93
Total Alkalinity as $CaCO_3$	0		04/07/93
Total Acidity as $CaCO_3$	9090		04/08/93
Specific Conductance @ 25°C	9450	µmhos/cm	04/07/93
pH	3.8	s.u.	04/07/93
Nitrate plus Nitrite as N	<0.05		04/09/93
Total Metals			
Iron	2490		04/06/93
Ferric Iron	100		04/07/93
Ferrous Iron	2390		04/07/93
Manganese	11.0		04/08/93
Zinc	55.4		04/08/93
Aluminum	569		04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine & Reclamation Bureau
1625 Eleventh Avenue
Helena, MT 59620

LAB NO.: 93-12961 spi
DATE: 04/15/93 ag

QUALITY ASSURANCE - SPIKED ANALYSIS

Stockett Wetlands
North Middle Discharge, SWWND-4-5
Sampled 04/05/93
Submitted 04/06/93

Constituent	% Recovery	Date Analyzed
Calcium	100	04/13/93
Magnesium	100	04/13/93
Sulfate	100	04/12/93
Total Dissolved Solids @ 180°C	N/A	N/A
Total Alkalinity as $CaCO_3$	N/A	N/A
Total Acidity as $CaCO_3$	N/A	N/A
Specific Conductance @ 25°C	N/A	N/A
pH	N/A	N/A
Nitrate plus Nitrite as N	101	04/09/93
Total Metals		
Iron	99	04/06/93
Ferric Iron	N/A	N/A
Ferrous Iron	93	04/07/93
Manganese	99	04/08/93
Zinc	100	04/08/93
Aluminum	99	04/08/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18015
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, SWWSE-5-6
Sampled 05/06/93 @ 1500
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	465		05/11/93
Magnesium	293		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	8980		05/11/93
Specific Conductance @ 25°C	8470	µmhos/cm	05/10/93
pH	2.6	s.u.	05/10/93
Sulfate	10600		05/14/93
Nitrate plus Nitrite as N	1.05		05/10/93
Total Dissolved Solids @ 180°C	16200		05/11/93
Total Metals			
Aluminum	1250		05/17/93
Iron	878		05/07/93
Ferric Iron	508		05/07/93
Ferrous Iron	370		05/07/93
Manganese	9.72		05/11/93
Zinc	65.4		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18014
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, SWWSI-5-6
Sampled 05/06/93 @ 1500
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	450		05/11/93
Magnesium	290		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	9370		05/11/93
Specific Conductance @ 25°C	8600	µmhos/cm	05/10/93
pH	2.6	s.u.	05/10/93
Sulfate	10400		05/14/93
Nitrate plus Nitrite as N	0.87		05/10/93
Total Dissolved Solids @ 180°C	15700		05/18/93
Total Metals			
Aluminum	1200		05/17/93
Iron	1170		05/07/93
Ferric Iron	580		05/07/93
Ferrous Iron	590		05/07/93
Manganese	8.81		05/11/93
Zinc	62.8		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18016
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, SWWNI-5-6
Sampled 05/06/93 @ 1500
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	468		05/11/93
Magnesium	273		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	9850		05/11/93
Specific Conductance @ 25°C	9190	µmhos/cm	05/10/93
pH	2.7	s.u.	05/10/93
Sulfate	11000		05/14/93
Nitrate plus Nitrite as N	0.66		05/12/93
Total Dissolved Solids @ 180°C	17700		05/11/93
Total Metals			
Aluminum	1350		05/17/93
Iron	1670		05/07/93
Ferric Iron	350		05/07/93
Ferrous Iron	1320		05/07/93
Manganese	6.81		05/11/93
Zinc	77.2		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18017
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, SWWNMD-5-6
Sampled 05/06/93 @ 1500
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	438		05/11/93
Magnesium	528		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	7270		05/11/93
Specific Conductance @ 25°C	9030	µmhos/cm	05/10/93
pH	3.6	s.u.	05/10/93
Sulfate	9400		05/14/93
Nitrate plus Nitrite as N	<0.05		05/10/93
Total Dissolved Solids @ 180°C	15700		05/11/93
Total Metals			
Aluminum	582		05/17/93
Iron	2360		05/07/93
Ferric Iron	170		05/07/93
Ferrous Iron	2190		05/07/93
Manganese	13.0		05/11/93
Zinc	51.5		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18018
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, SWWNE-5-6
Sampled 05/06/93 @ 1500
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	477		05/11/93
Magnesium	400		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	9240		05/11/93
Specific Conductance @ 25°C	9160	µmhos/cm	05/10/93
pH	2.7	s.u.	05/10/93
Sulfate	10300		05/14/93
Nitrate plus Nitrite as N	0.37		05/12/93
Total Dissolved Solids @ 180°C	16500		05/11/93
Total Metals			
Aluminum	1000		05/17/93
Iron	1630		05/07/93
Ferric Iron	260		05/07/93
Ferrous Iron	1370		05/07/93
Manganese	8.88		05/11/93
Zinc	58.4		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Dept. of State Lands
Abandoned Mine Reclamation Bureau
1625 11th Avenue
Helena, MT 59601

LAB NO.: 93-18019
DATE: 05/21/93 crp

WATER ANALYSIS

Bect/Stockett, SWWOE-5-6
Sampled 05/06/93 @ 1500
Submitted 05/07/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	456		05/11/93
Magnesium	347		05/11/93
Total Alkalinity as $CaCO_3$	0		05/10/93
Total Acidity as $CaCO_3$	8980		05/11/93
Specific Conductance @ 25°C	8620	µmhos/cm	05/10/93
pH	2.5	s.u.	05/10/93
Sulfate	10700		05/14/93
Nitrate plus Nitrite as N	1.25		05/12/93
Total Dissolved Solids @ 180°C	16200		05/11/93
Total Metals			
Aluminum	1050		05/17/93
Iron	1160		05/07/93
Ferric Iron	429		05/07/93
Ferrous Iron	731		05/07/93
Manganese	10.1		05/11/93
Zinc	60.2		05/11/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22410
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWSI-6-7
South Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	430		06/10/93
Magnesium	269		06/10/93
Sulfate	10800		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	17000		06/09/93
Specific Conductance @ 25°C	8300	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	9090		06/09/93
Nitrate plus Nitrite as N	1.28		06/16/93
Total Metals			
Aluminum	1080		06/11/93
Iron	1190		06/10/93
Ferrous Iron	602		06/11/93
Ferric Iron	588		06/11/93
Manganese	8.09		06/10/93
Zinc	58.0		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22410 dup
DATE: 06/23/93 da

QUALITY ASSURANCE-DUPLICATE ANALYSIS

Stockett Wetlands
SWWSI-6-7
South Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	429		06/10/93
Magnesium	269		06/10/93
Sulfate	10800		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	17000		06/09/93
Specific Conductance @ 25°C	8300	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	9230		06/09/93
Nitrate plus Nitrite as N	1.26		06/16/93
Total Metals			
Aluminum	1090		06/11/93
Iron	1180		06/10/93
Ferrous Iron	605		06/11/93
Ferric Iron	575		06/11/93
Manganese	8.04		06/10/93
Zinc	57.7		06/10/93

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22411
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWSE-6-7
South Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	402		06/14/93
Magnesium	261		06/14/93
Sulfate	10900		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	17000		06/09/93
Specific Conductance @ 25°C	8280	µmhos/cm	06/09/93
pH	2.6	s.u.	06/09/93
Total Acidity as $CaCO_3$	9380		06/09/93
Nitrate plus Nitrite as N	1.14		06/16/93
Total Metals			
Aluminum	999		06/11/93
Iron	995		06/10/93
Ferrous Iron	331		06/12/93
Ferric Iron	664		06/12/93
Manganese	8.59		06/10/93
Zinc	58.4		06/10/93

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22411 spi
DATE: 06/23/93 da

QUALITY ASSURANCE-SPIKED ANALYSIS

Stockett Wetlands
SWWSE-6-7
South Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	% Recovery	Date Analyzed
Calcium	96	06/14/93
Magnesium	96	06/14/93
Sulfate	99	06/18/93
Total Alkalinity as $CaCO_3$	N/A	N/A
Total Dissolved Solids @ 180°C	N/A	N/A
Specific Conductance @ 25°C	N/A	N/A
pH	N/A	N/A
Total Acidity as $CaCO_3$	N/A	N/A
Nitrate plus Nitrite as N	98	06/16/93
Total Metals		
Aluminum	109	06/11/93
Iron	100	06/10/93
Ferrous Iron	90	06/12/93
Ferric Iron	N/A	N/A
Manganese	99	06/10/93
Zinc	98	06/10/93

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22412
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWNI-6-7
North Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	505	06/10/93
Magnesium	291	06/10/93
Sulfate	11900	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	18900	06/09/93
Specific Conductance @ 25°C	9200	06/09/93
pH	2.8	06/09/93
Total Acidity as $CaCO_3$	10620	06/09/93
Nitrate plus Nitrite as N	0.54	06/16/93
Total Metals		
Aluminum	1140	06/11/93
Iron	1600	06/10/93
Ferrous Iron	777	06/11/93
Ferric Iron	823	06/11/93
Manganese	6.75	06/10/93
Zinc	67.3	06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22413
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWMI-6-7
Middle Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	430	06/10/93
Magnesium	530	06/10/93
Sulfate	10000	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	16200	06/09/93
Specific Conductance @ 25°C	9010	06/09/93
pH	3.8	06/09/93
Total Acidity as $CaCO_3$	7390	06/09/93
Nitrate plus Nitrite as N	<0.05	06/16/93
Total Metals		
Aluminum	527	06/11/93
Iron	2420	06/10/93
Ferrous Iron	1730	06/11/93
Ferric Iron	690	06/11/93
Manganese	13.3	06/10/93
Zinc	50.1	06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22414
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWNE-6-7
North Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	459	06/10/93
Magnesium	348	06/10/93
Sulfate	11400	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	18100	06/09/93
Specific Conductance @ 25°C	8990	06/09/93
pH	2.8	06/09/93
Total Acidity as $CaCO_3$	9670	06/09/93
Nitrate plus Nitrite as N	0.26	06/16/93
Total Metals		
Aluminum	1070	06/11/93
Iron	1660	06/10/93
Ferrous Iron	940	06/11/93
Ferric Iron	720	06/11/93
Manganese	9.28	06/10/93
Zinc	65.5	06/10/93

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22415
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWOE-6-7
Outflow Discharge
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	433	06/10/93
Magnesium	319	06/10/93
Sulfate	11200	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	17700	06/09/93
Specific Conductance @ 25°C	8950	06/09/93
pH	2.7	06/09/93
Total Acidity as $CaCO_3$	9550	06/09/93
Nitrate plus Nitrite as N	0.54	06/16/93
Total Metals		
Aluminum	1070	06/11/93
Iron	1310	06/10/93
Ferrous Iron	762	06/11/93
Ferric Iron	548	06/11/93
Manganese	8.67	06/10/93
Zinc	57.2	06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22410
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWSI-6-7
South Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	430		06/10/93
Magnesium	269		06/10/93
Sulfate	10800		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	17000		06/09/93
Specific Conductance @ 25°C	8300	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	9090		06/09/93
Nitrate plus Nitrite as N	1.28		06/16/93
Total Metals			
Aluminum	1080		06/11/93
Iron	1190		06/10/93
Ferrous Iron	602		06/11/93
Ferric Iron	588		06/11/93
Manganese	8.09		06/10/93
Zinc	58.0		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22410 dup
DATE: 06/23/93 da

QUALITY ASSURANCE-DUPLICATE ANALYSIS

Stockett Wetlands
SWWSI-6-7
South Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	429		06/10/93
Magnesium	269		06/10/93
Sulfate	10800		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	17000		06/09/93
Specific Conductance @ 25°C	8300	µmhos/cm	06/09/93
pH	2.7	s.u.	06/09/93
Total Acidity as $CaCO_3$	9230		06/09/93
Nitrate plus Nitrite as N	1.26		06/16/93
Total Metals			
Aluminum	1090		06/11/93
Iron	1180		06/10/93
Ferrous Iron	605		06/11/93
Ferric Iron	575		06/11/93
Manganese	8.04		06/10/93
Zinc	57.7		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22411
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWSE-6-7
South Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	402		06/14/93
Magnesium	261		06/14/93
Sulfate	10900		06/18/93
Total Alkalinity as $CaCO_3$	0		06/09/93
Total Dissolved Solids @ 180°C	17000		06/09/93
Specific Conductance @ 25°C	8280	µmhos/cm	06/09/93
pH	2.6	s.u.	06/09/93
Total Acidity as $CaCO_3$	9380		06/09/93
Nitrate plus Nitrite as N	1.14		06/16/93
Total Metals			
Aluminum	999		06/11/93
Iron	995		06/10/93
Ferrous Iron	331		06/12/93
Ferric Iron	664		06/12/93
Manganese	8.59		06/10/93
Zinc	58.4		06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22411 spi
DATE: 06/23/93 da

QUALITY ASSURANCE-SPIKED ANALYSIS

Stockett Wetlands
SWWSE-6-7
South Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	% Recovery	Date Analyzed
Calcium	96	06/14/93
Magnesium	96	06/14/93
Sulfate	99	06/18/93
Total Alkalinity as $CaCO_3$	N/A	N/A
Total Dissolved Solids @ 180°C	N/A	N/A
Specific Conductance @ 25°C	N/A	N/A
pH	N/A	N/A
Total Acidity as $CaCO_3$	N/A	N/A
Nitrate plus Nitrite as N	98	06/16/93
Total Metals		
Aluminum	109	06/11/93
Iron	100	06/10/93
Ferrous Iron	90	06/12/93
Ferric Iron	N/A	N/A
Manganese	99	06/10/93
Zinc	98	06/10/93

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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22412
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWNI-6-7
North Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	505	06/10/93
Magnesium	291	06/10/93
Sulfate	11900	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	18900	06/09/93
Specific Conductance @ 25°C	9200	06/09/93
pH	2.8	06/09/93
Total Acidity as $CaCO_3$	10620	06/09/93
Nitrate plus Nitrite as N	0.54	06/16/93
Total Metals		
Aluminum	1140	06/11/93
Iron	1600	06/10/93
Ferrous Iron	777	06/11/93
Ferric Iron	823	06/11/93
Manganese	6.75	06/10/93
Zinc	67.3	06/10/93

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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22413
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWMI-6-7
Middle Influent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	430	06/10/93
Magnesium	530	06/10/93
Sulfate	10000	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	16200	06/09/93
Specific Conductance @ 25°C	9010	06/09/93
pH	3.8	06/09/93
Total Acidity as $CaCO_3$	7390	06/09/93
Nitrate plus Nitrite as N	<0.05	06/16/93
Total Metals		
Aluminum	527	06/11/93
Iron	2420	06/10/93
Ferrous Iron	1730	06/11/93
Ferric Iron	690	06/11/93
Manganese	13.3	06/10/93
Zinc	50.1	06/10/93

ENERGY LABORATORIES, INC.
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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22414
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWNE-6-7
North Effluent
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	459	06/10/93
Magnesium	348	06/10/93
Sulfate	11400	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	18100	06/09/93
Specific Conductance @ 25°C	8990	06/09/93
pH	2.8	06/09/93
Total Acidity as $CaCO_3$	9670	06/09/93
Nitrate plus Nitrite as N	0.26	06/16/93
Total Metals		
Aluminum	1070	06/11/93
Iron	1660	06/10/93
Ferrous Iron	940	06/11/93
Ferric Iron	720	06/11/93
Manganese	9.28	06/10/93
Zinc	65.5	06/10/93

ENERGY LABORATORIES, INC.
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FAX (406) 252-6069 • 1-800-735-4489

LABORATORY REPORT

TO: Earl McCurley
ADDRESS: MT Dept. of State Lands
1625 11th Ave.
Helena, MT 59601

LAB NO.: 93-22415
DATE: 06/23/93 da

WATER ANALYSIS

Stockett Wetlands
SWWOE-6-7
Outflow Discharge
Sampled 06/07/93 @ 1500
Submitted 06/08/93

Constituent	mg/l (ppm)	Date Analyzed
Calcium	433	06/10/93
Magnesium	319	06/10/93
Sulfate	11200	06/18/93
Total Alkalinity as $CaCO_3$	0	06/09/93
Total Dissolved Solids @ 180°C	17700	06/09/93
Specific Conductance @ 25°C	8950	06/09/93
pH	2.7	06/09/93
Total Acidity as $CaCO_3$	9550	06/09/93
Nitrate plus Nitrite as N	0.54	06/16/93
Total Metals		
Aluminum	1070	06/11/93
Iron	1310	06/10/93
Ferrous Iron	762	06/11/93
Ferric Iron	548	06/11/93
Manganese	8.67	06/10/93
Zinc	57.2	06/10/93

ENERGY LABORATORIES, INC.
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LABORATORY REPORT

TO: Earl McCurley
ADDRESS: Montana Department of State Lands
1625 11th Avenue
Helena, MT 59620

LAB NO: 93-28005
DATE: 07/20/93 dlf

WATER ANALYSIS

Wetland Water Samples
Stockett, Total Outflow, SWWTO-7-8
Sampled 07/08/93 @ 1600
Submitted 07/09/93

Constituent	mg/l (ppm)		Date Analyzed
Calcium	435		07/13/93
Magnesium	258		07/13/93
Sulfate	9190		07/13/93
Total Dissolved Solids @ 180°C	13800		07/12/93
Total Alkalinity as $CaCO_3$	<1		07/12/93
Specific Conductance @ 25°C	7590	µmhos/cm	07/12/93
pH	2.7	s.u.	07/12/93
Total Acidity as $CaCO_3$	7270		07/12/93
Nitrate plus Nitrite as N	1.29		07/14/93
Total Metals			
Aluminum	1050		07/13/93
Iron	937		07/12/93
Ferrous Iron	488		07/13/93
Ferric Iron	449		07/13/93
Manganese	10.6		07/13/93
Zinc	65.5		07/13/93

TABLE C.1 STOCKETT SE NORTH DITCH DATA

Sample Date	Sample Location	Flow (gpm)	pH (su)	EC (umhos/cm)	Temp. (Deg C)	TDS (mg/L)	NO3+NO2 (mg/L)	SO4 (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	Fe (Total) (mg/L)	Fe (2+) (mg/L)	Fe (3+) (mg/L)	Mn (mg/L)	Zn (mg/L)	Al (mg/L)	Mg (mg/L)	Ca (mg/L)
09/03/92	SWWNi	NA	2.4	9640	NA	21000	NA	NA	12800	0	1780	1230	550	5.83	77.7	1460	256	439
09/03/92	SWWNims	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09/03/92	SWWNMID	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09/03/92	SWWNe	NA	2.4	10100	NA	20800	NA	NA	12000	0	1810	1360	450	12.6	80.2	1250	455	485
09/03/92	SWWoe	NA	2.4	9320	NA	19400	NA	NA	11400	0	1340	736	604	14.6	76.3	1280	388	482
10/05/92	SWWNi	NA	2.6	9550	NA	21300	0.05	11200	13000	0	1800	939	861	5.62	76.3	1460	253	449
10/05/92	SWWNims	NA	2.6	9590	NA	21500	0.05	11300	14300	0	1800	945	855	5.81	76.2	1490	247	440
10/05/92	SWWNMID	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10/05/92	SWWNe	NA	2.5	10600	NA	21100	0.08	13600	14100	0	2070	1410	660	13.3	81.4	1260	500	490
10/05/92	SWWoe	NA	2.7	9070	NA	16500	0.54	9900	10200	0	1300	694	606	21.3	62.2	937	465	709
11/02/92	SWWNi	3.0	2.7	8580	9.4	16100	0.14	9540	9380	0	2160	1070	1090	8.63	75.4	1000	274	449
11/02/92	SWWNims	1.0	2.7	9270	8.4	20700	0.15	11200	12600	0	2040	749	1291	7.02	89.5	1380	240	415
11/02/92	SWWNMID	0.8	3.6	9040	9.8	16800	0.07	9710	8230	0	2900	2240	660	13	65.4	568	510	414
11/02/92	SWWNe	3.2	2.8	8960	5.9	17200	0.7	9880	8920	0	2030	1160	870	11.9	77.3	987	392	423
11/02/92	SWWoe	5.0	2.9	7060	3.6	11500	0.41	6810	5460	0	1230	679	551	11.4	60.4	471	342	554
04/05/93	SWWNi	NA	2.8	8990	NA	17500	1.12	10900	9760	0	1580	1070	510	7.22	75.7	1180	266	462
04/05/93	SWWNims	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04/05/93	SWWNMID	NA	3.8	9450	NA	17100	0.05	10100	9090	0	2490	2390	100	11	55.4	569	1010	809
04/05/93	SWWNe	NA	2.8	7580	NA	13700	0.71	8810	7460	0	1120	741	379	8.43	59	842	305	408
04/05/93	SWWoe	NA	2.7	7080	NA	12700	0.57	8130	6810	0	500	314	186	10.8	53.4	809	313	436
05/06/93	SWWNi	NA	2.7	9190	NA	17700	0.66	11000	9850	0	1670	1320	350	6.81	77.2	1350	273	468
05/06/93	SWWNims	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05/06/93	SWWNMID	NA	3.6	9030	NA	15700	0.05	9400	7270	0	2360	2190	170	13	51.5	582	528	438
05/06/93	SWWNe	NA	2.7	9160	NA	16500	0.37	10300	9240	0	1630	1370	260	8.88	58.4	1000	400	477
05/06/93	SWWoe	NA	2.5	8620	NA	16200	1.25	10700	8980	0	1160	731	429	10.1	60.2	1050	347	456
06/07/93	SWWNi	4.0	2.8	9200	11.3	18900	0.54	11900	10620	0	1600	777	823	6.75	67.3	1140	291	505
06/07/93	SWWNims	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
06/07/93	SWWNMID	1.0	3.8	9010	9.8	16200	0.05	10000	7390	0	2420	1730	690	13.3	50.1	527	530	430
06/07/93	SWWNe	4.2	2.8	8990	15.8	18100	0.26	11400	9670	0	1660	940	720	9.28	65.5	1070	348	459
06/07/93	SWWoe	6.1	2.7	8950	15.3	17700	0.54	11200	9550	0	1310	762	548	8.67	57.2	1070	319	433
07/08/93	SWWoe	NA	2.7	7590	NA	13800	1.29	9190	7270	0	937	488	449	10.6	65.5	1050	258	435

SWWNi = North Ditch influent; SWWNims = North Ditch ALD effluent; SWWNMiD = North Ditch middle influent; SWWNe = North Ditch effluent; SWWNoe = Combined North and West Ditch effluent.

TABLE C.2 STOCKETT SE WEST DITCH DATA

Sample Date	Sample Location	Flow (gpm)	pH (su)	EC (umhos/cm)	Temp. (Deg C)	TDS (mg/L)	SO4 (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	Fe (Total) (mg/L)	Fe (2+) (mg/L)	Fe (3+) (mg/L)	Mn (mg/L)	Zn (mg/L)	Al (mg/L)	Mg (mg/L)	Ca (mg/L)
09/03/92	SWWSI	NA	2.4	8550	NA	17800	NA	10500	NA	1460	949	511	8.13	80	1140	282	429
09/03/92	SWWIms	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
09/03/92	SWWSe	NA	2.4	9020	NA	18900	NA	11000	NA	1290	730	560	13.6	91.9	1220	324	494
09/03/92	SWWoe	NA	2.4	9320	NA	19400	NA	11400	NA	1340	736	604	14.6	76.3	1280	388	482
10/05/92	SWWSI	NA	2.7	9080	NA	18000	10200	11400	0	1560	1080	480	6.93	65	1190	290	447
10/05/92	SWWIms	NA	6.1	5790	NA	6860	3320	0	701	596	572	24	33.3	19.3	8.1	353	942
10/05/92	SWWSe	NA	2.6	8110	NA	13400	8300	6720	0	633	262	371	26.6	41.7	594	432	829
10/05/92	SWWoe	NA	2.7	9070	NA	16500	9900	10200	0	1300	694	606	21.3	62.2	937	465	709
11/02/92	SWWSI	1.8	2.9	8800	9.9	18400	10400	10900	0	1780	944	836	7.74	78.6	1250	272	425
11/02/92	SWWIms	NA	5.8	6290	12.3	8400	4590	1230	508	1310	966	344	9.96	74.1	17.6	304	597
11/02/92	SWWSe	3.5	4.1	5270	3.2	7530	4380	1730	0	917	587	330	10.3	65.7	5.6	299	593
11/02/92	SWWoe	NA	2.9	7060	NA	11500	6810	5460	0	1230	679	551	11.4	60.4	471	342	554
04/05/93	SWWSI	NA	2.8	8670	NA	16600	11100	9910	0	1230	910	320	8.21	65.2	1210	276	430
04/05/93	SWWIms	NA	3.8	7680	NA	14800	9130	8000	0	1140	1010	130	8.24	71.4	1110	588	930
04/05/93	SWWSe	NA	3.0	6850	NA	12600	7930	6540	0	396	379	17	8.04	57.4	886	287	438
04/05/93	SWWoe	NA	2.7	7080	NA	12700	8130	6810	0	500	314	186	10.8	53.4	809	313	436
05/06/93	SWWSI	NA	2.6	8600	NA	15700	10400	9370	0	1170	590	580	8.81	62.8	1200	290	450
05/06/93	SWWIms	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05/06/93	SWWSe	NA	2.6	8470	NA	16200	10600	8980	0	878	370	508	9.72	65.4	1250	293	465
05/06/93	SWWoe	NA	2.5	8620	NA	16200	10700	8980	0	1160	731	429	10.1	60.2	1050	347	456

SWWSI = West Ditch influent; SWWSIms = West Ditch ALD effluent; SWWSe = West Ditch effluent; SWWoe = combined North and West Ditch effluent.

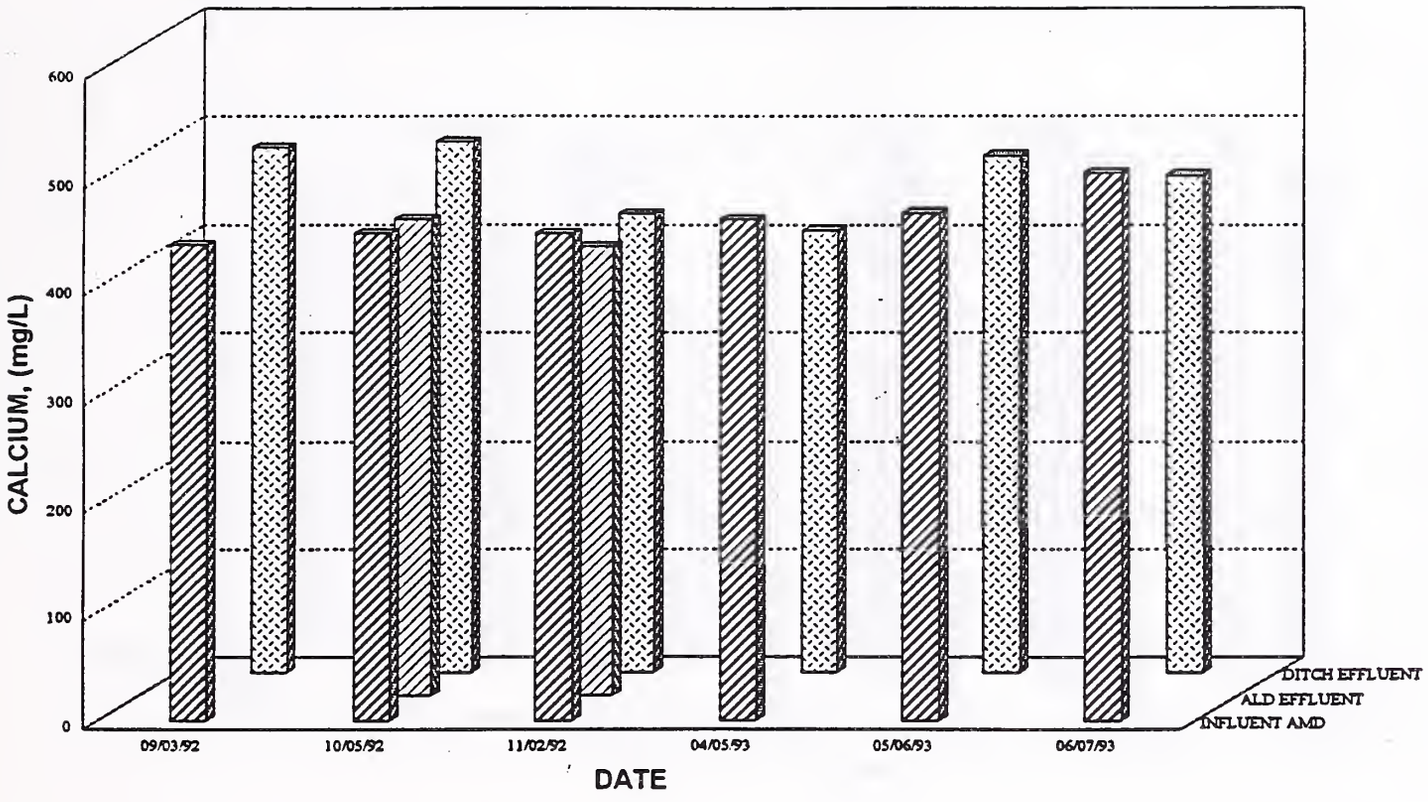

Figure C.1 Calcium analyses at the Stockett North Ditch since start-up.

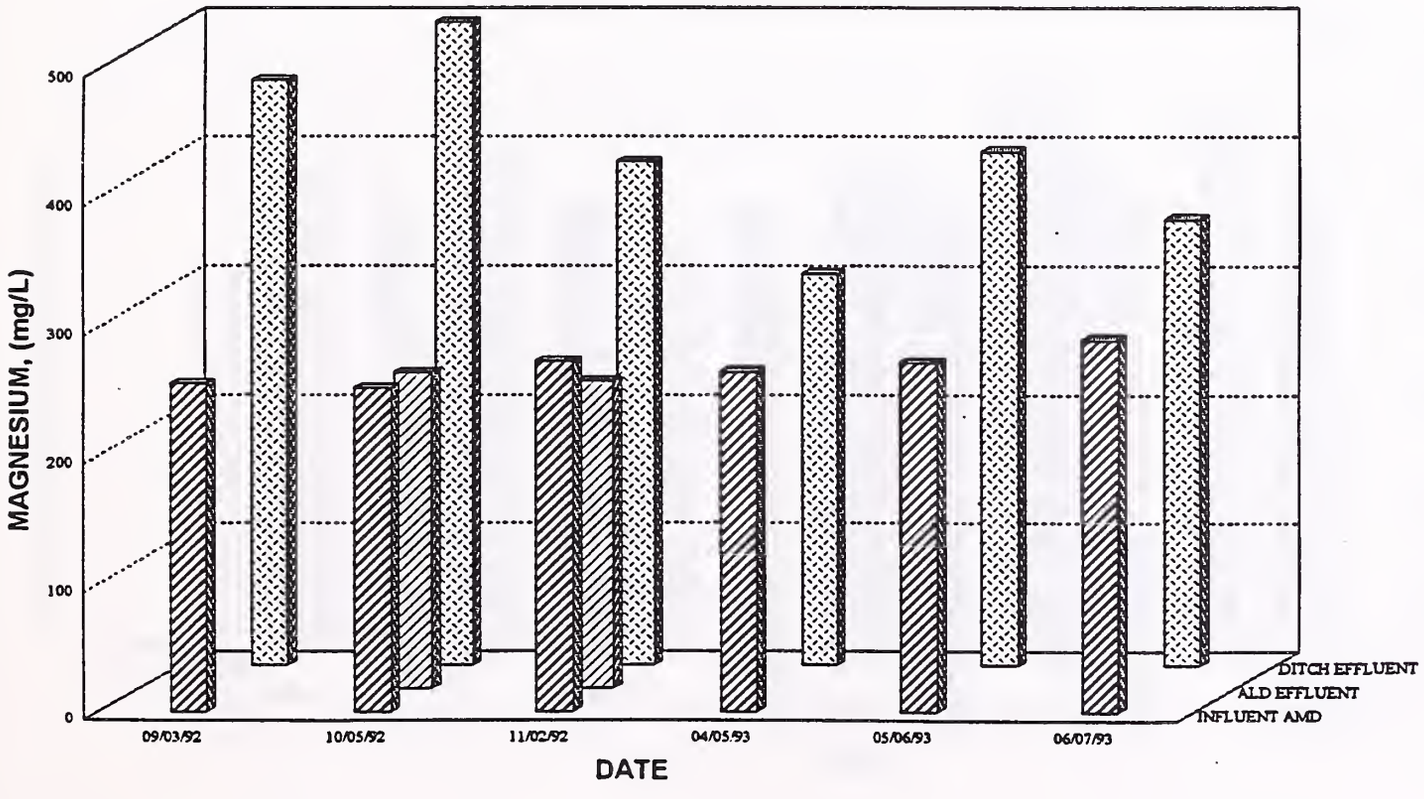

Figure C.2 Magnesium analyses at the Stockett North Ditch since start-up.

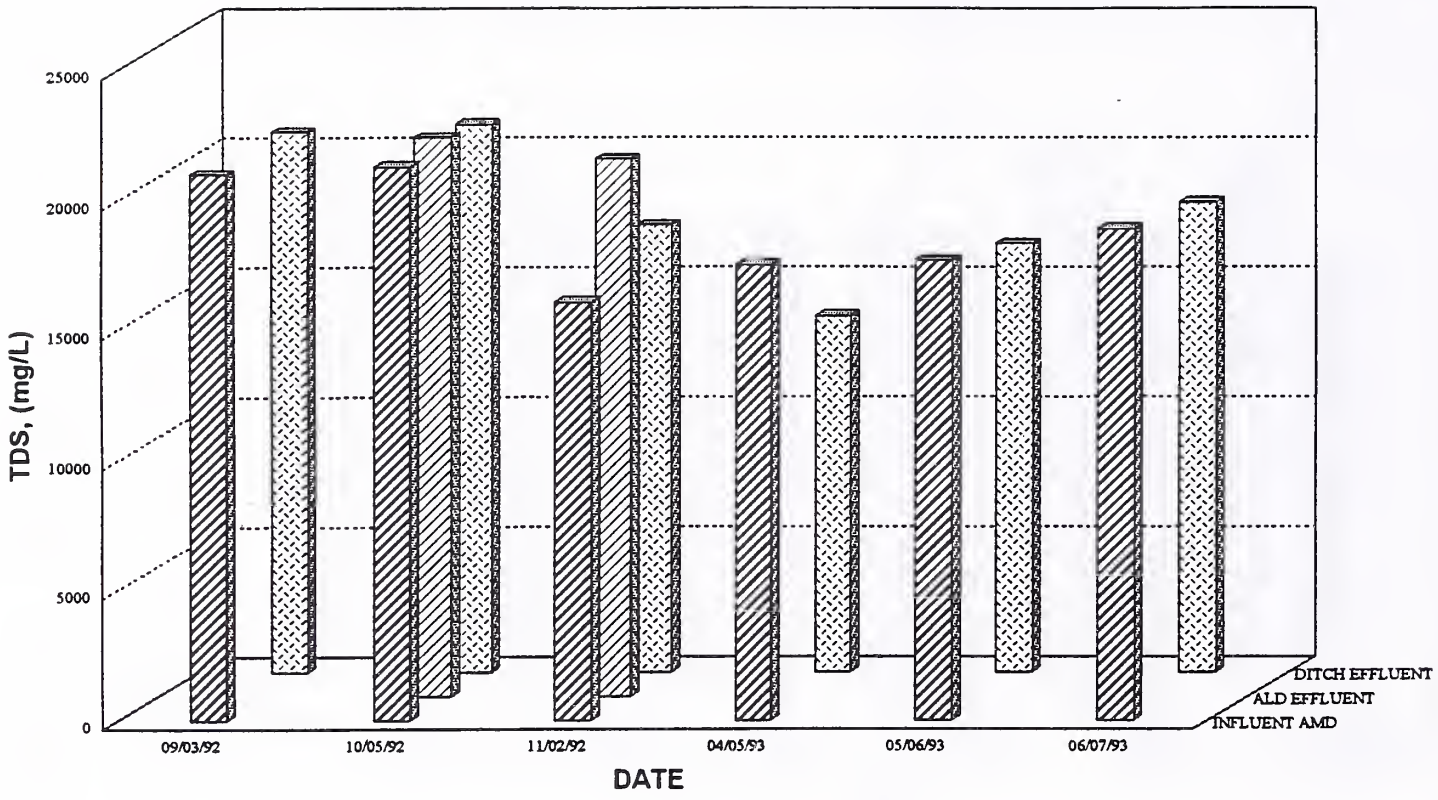

Figure C.3 TDS analyses at the Stockett North Ditch since start-up.

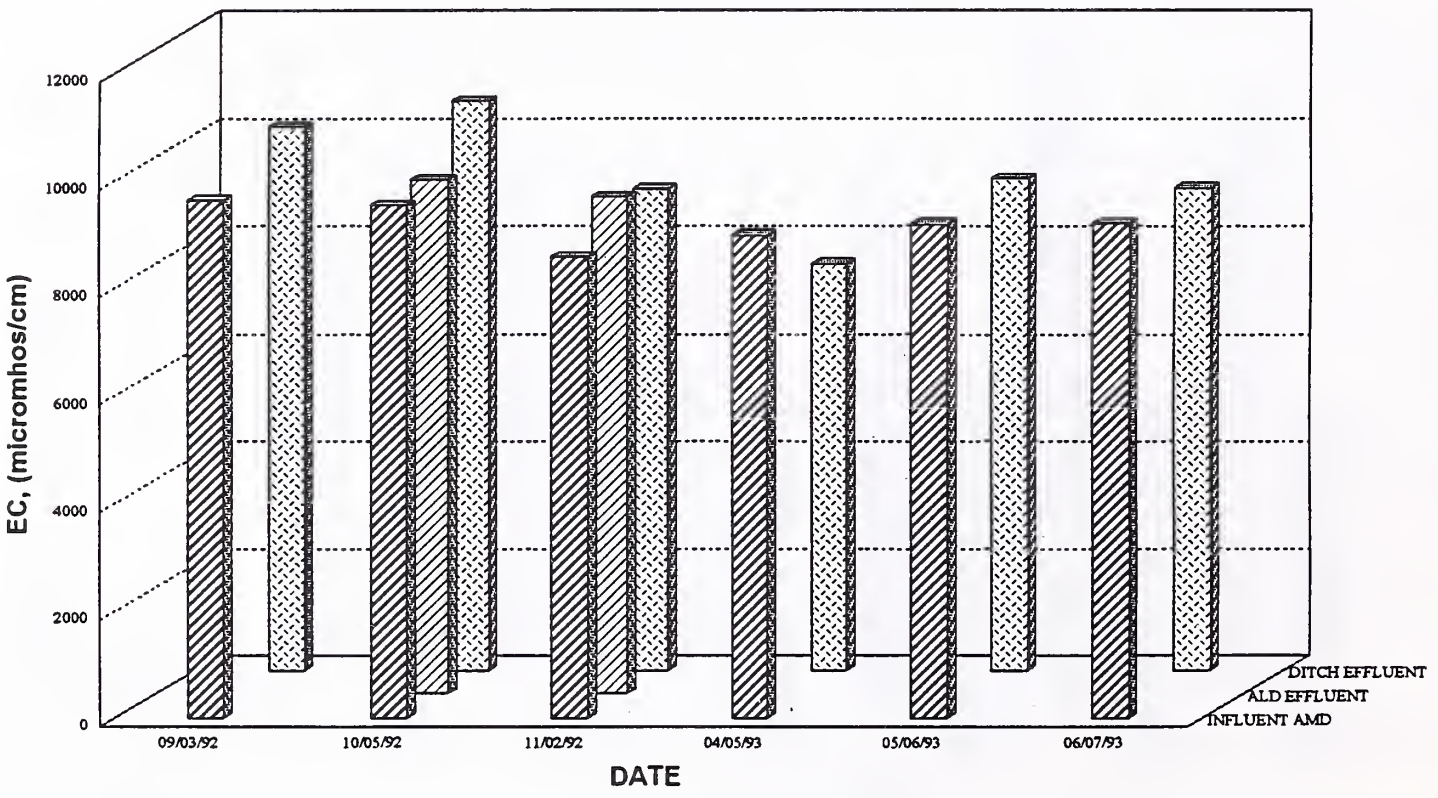

Figure C.4 EC of waters at the Stockett North Ditch since start-up.

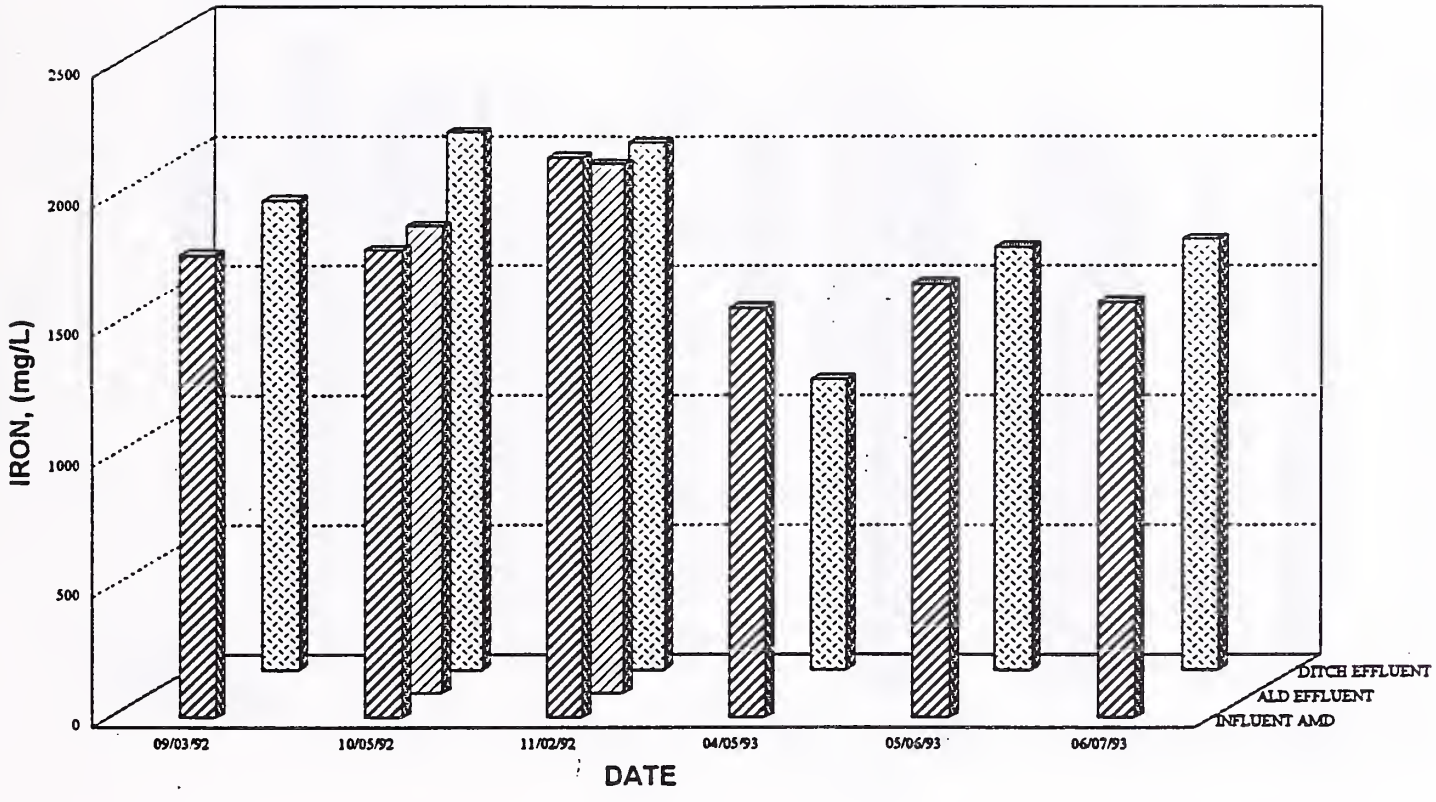

Figure C.5 Iron analyses at the Stockett North Ditch since start-up.

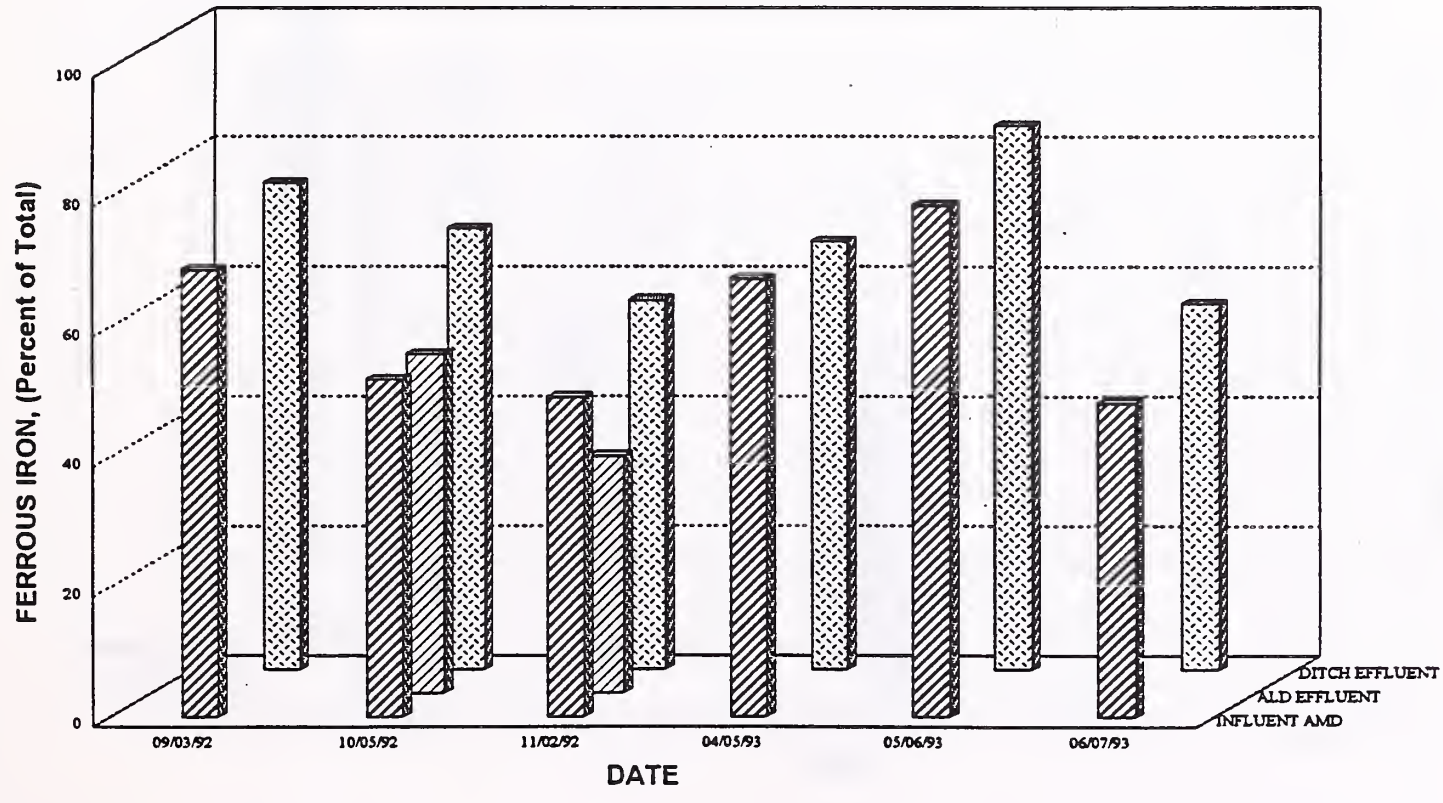

Figure C.6 Ferrous/Ferric ratios at the Stockett North Ditch since start-up.

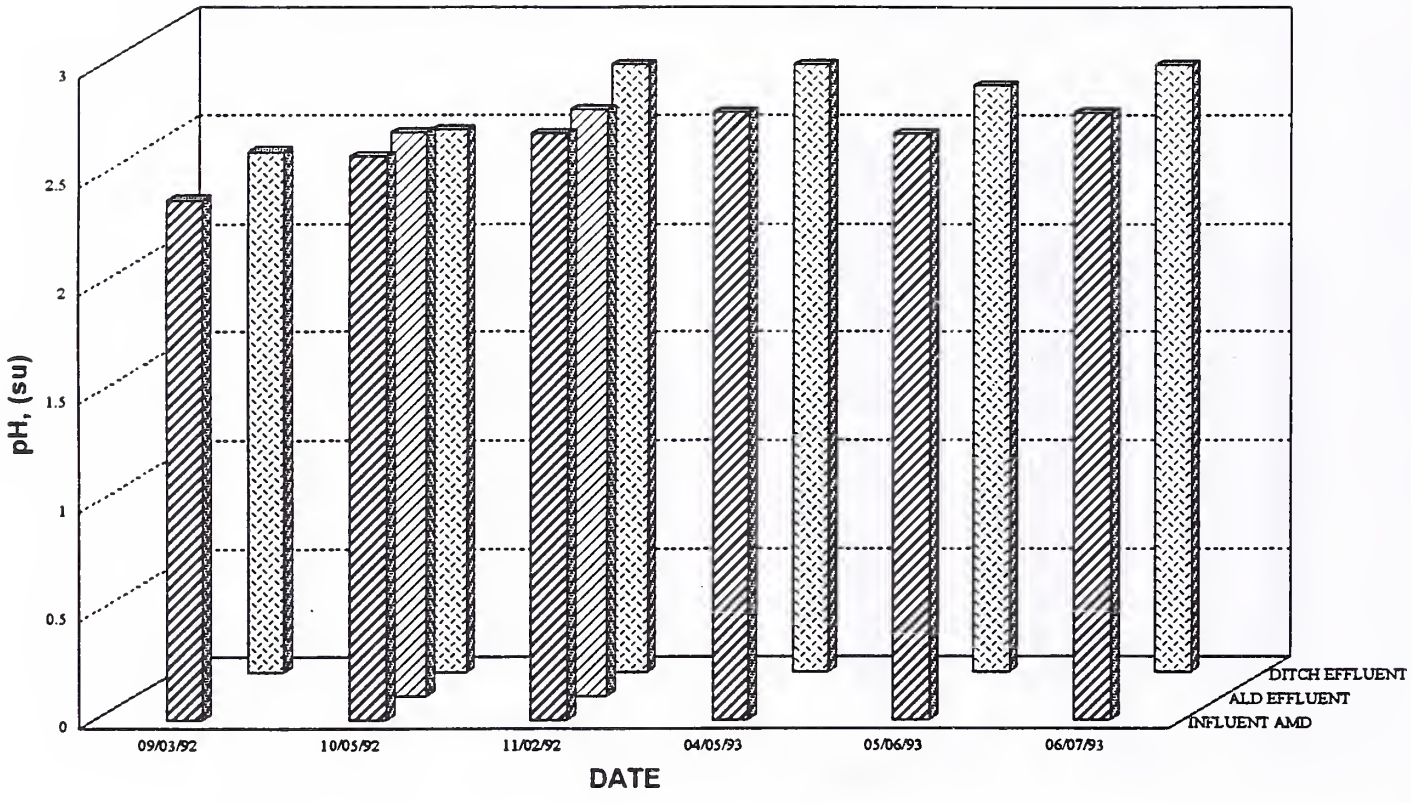

Figure C.7 pH measurements at the Stockett North Ditch since start-up.

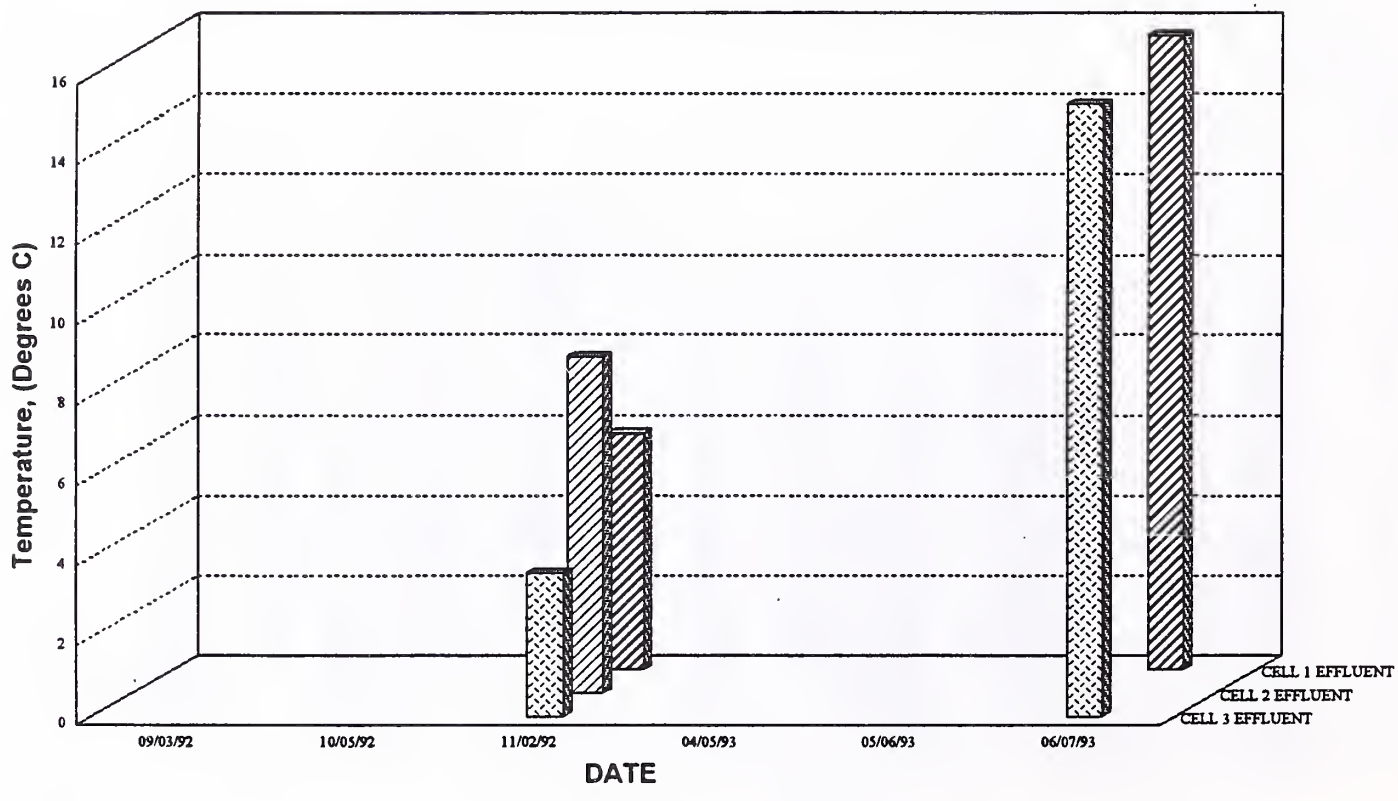

Figure C.8 Temperature measurements at the Stockett North Ditch since start-up.

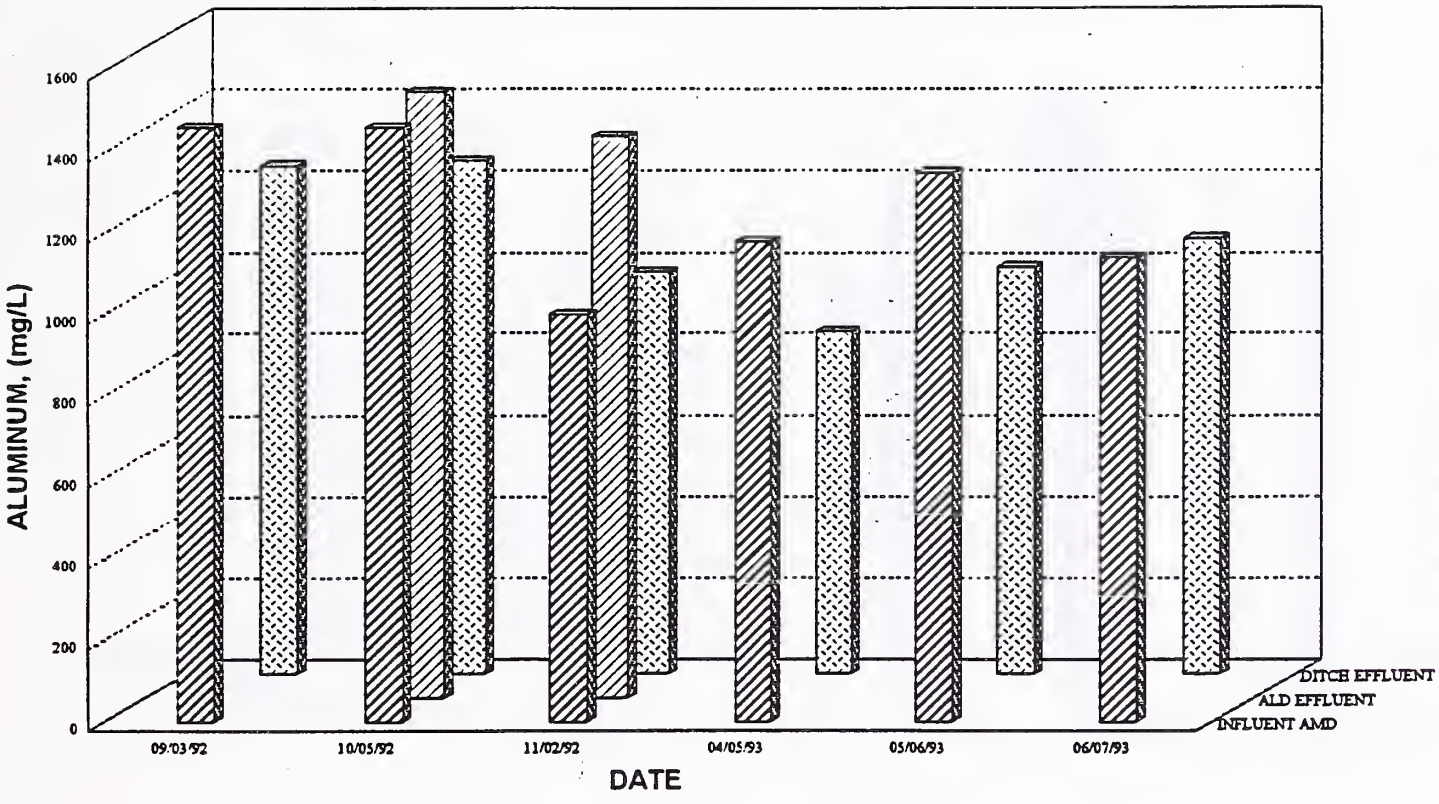

Figure C.9 Aluminum analyses at the Stockett North Ditch since start-up.

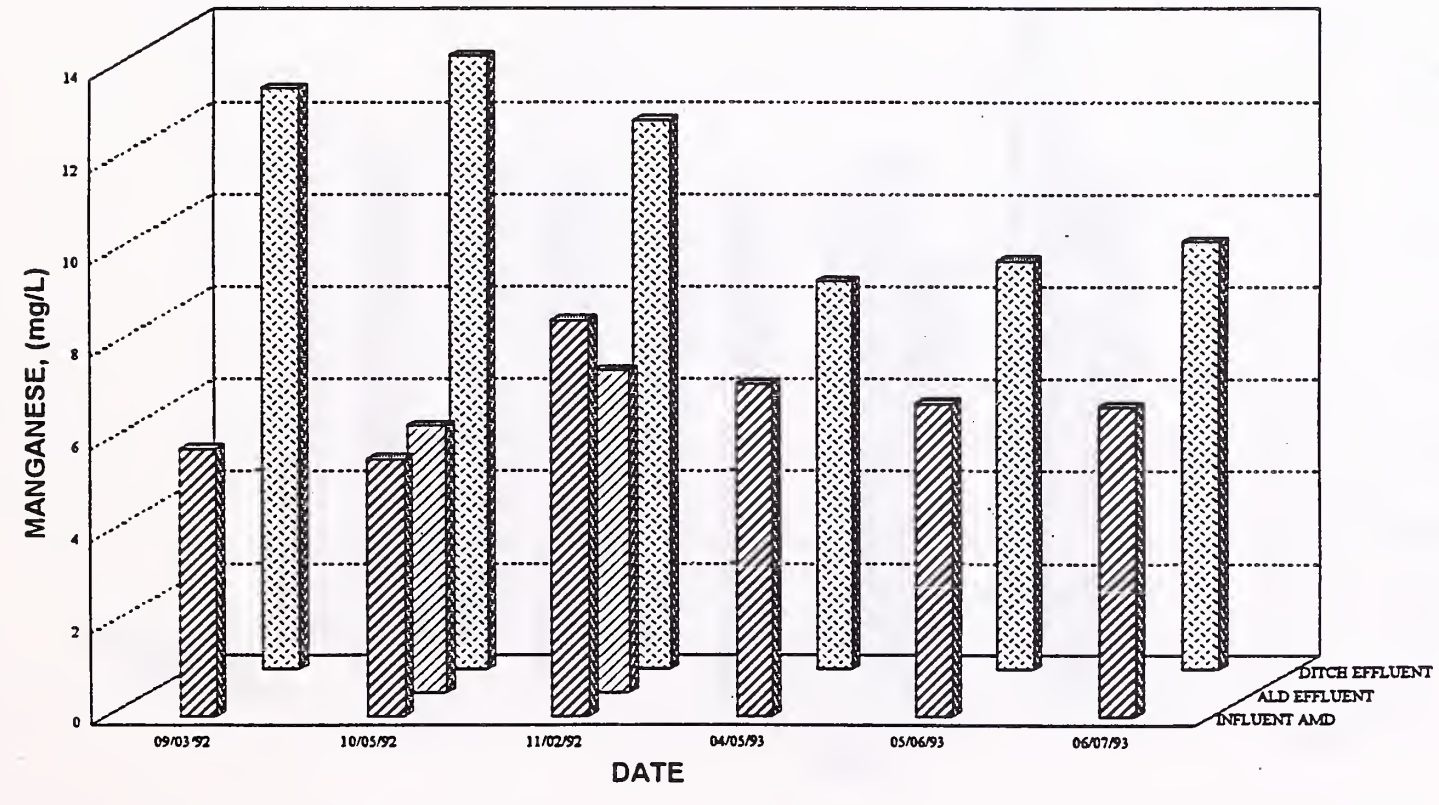

Figure C.10 Manganese analyses at the Stockett North Ditch since start-up.

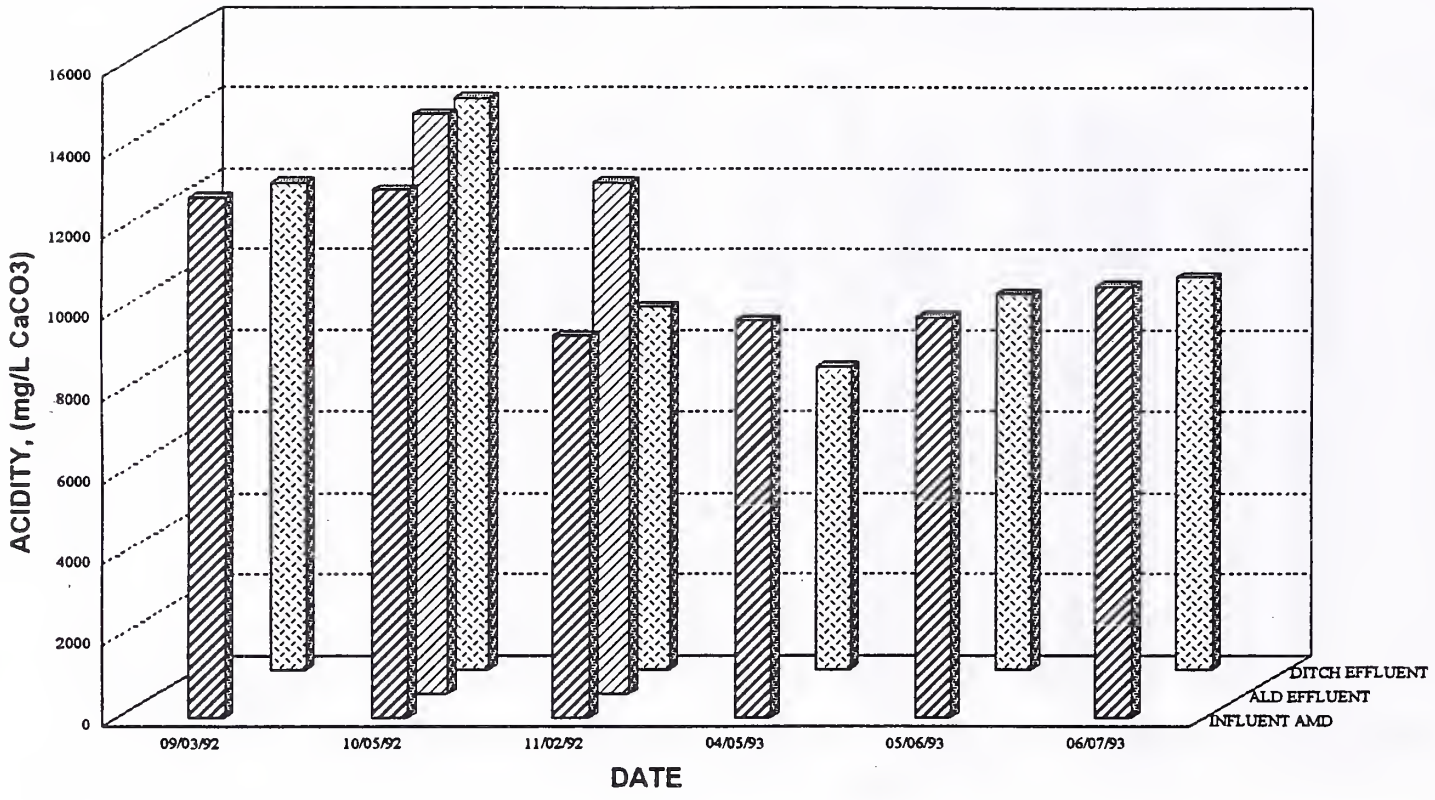

Figure C.11 Acidity analyses at the Stockett North Ditch since start-up.

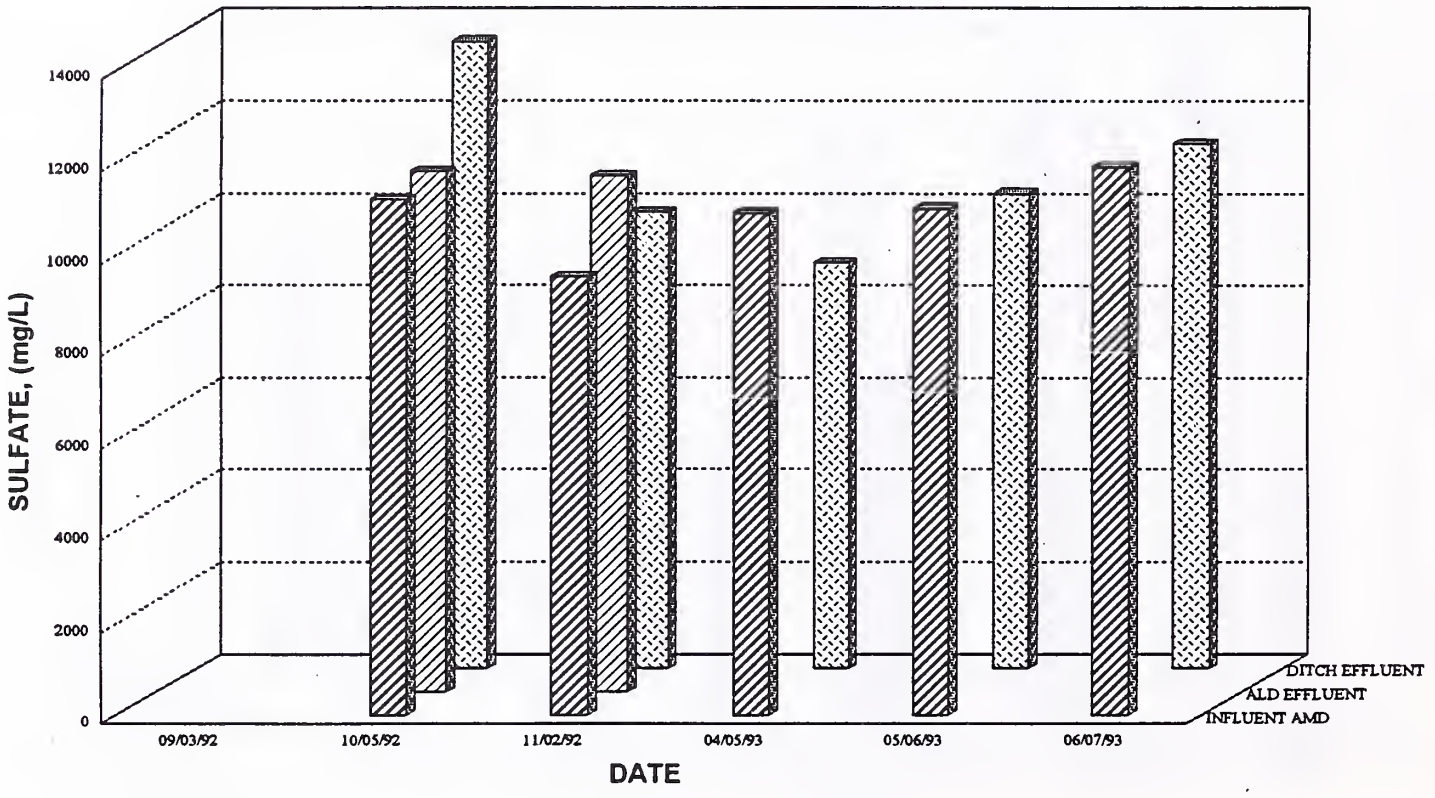

Figure C.12 Sulfate analyses at the Stockett North Ditch since start-up.

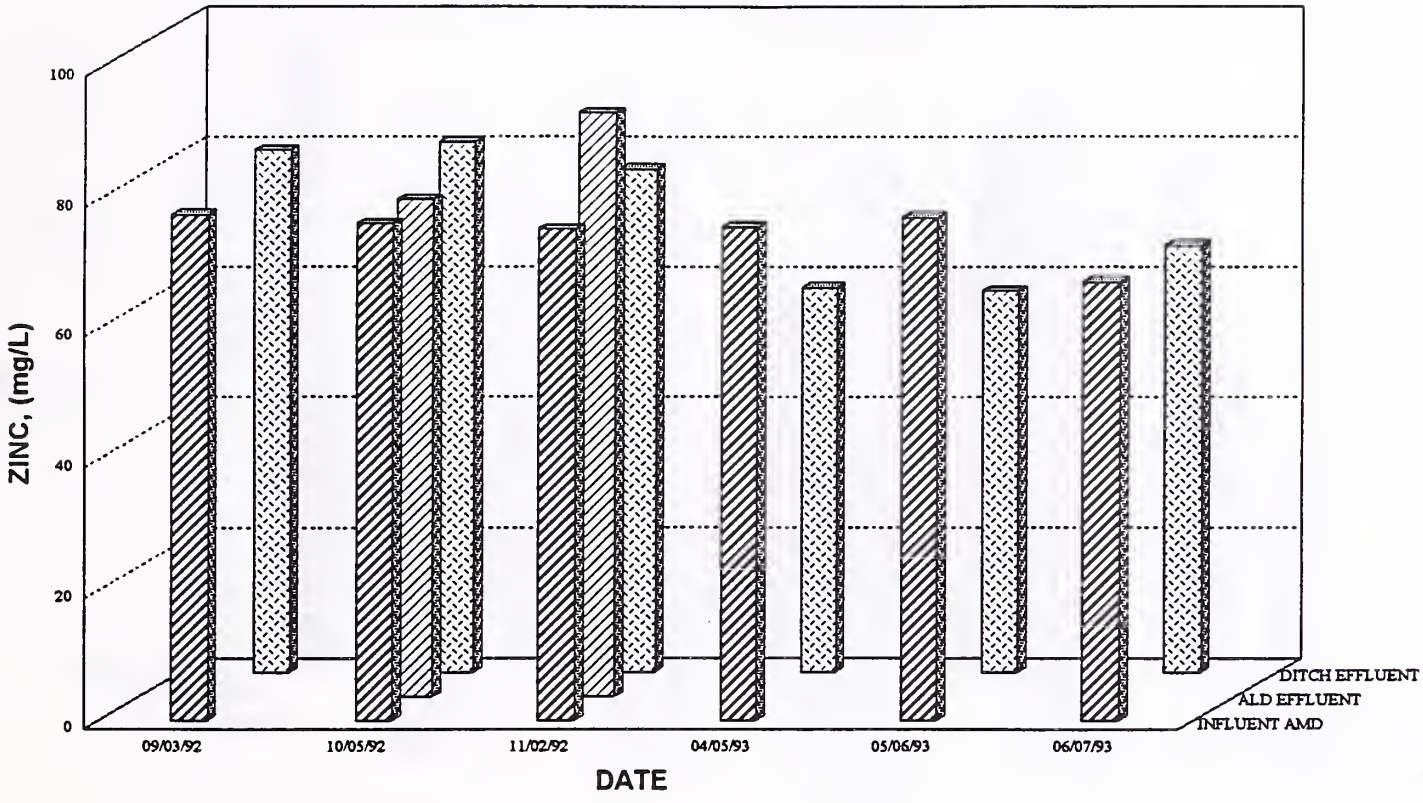

Figure C.13 Zinc analyses at the Stockett North Ditch since start-up.

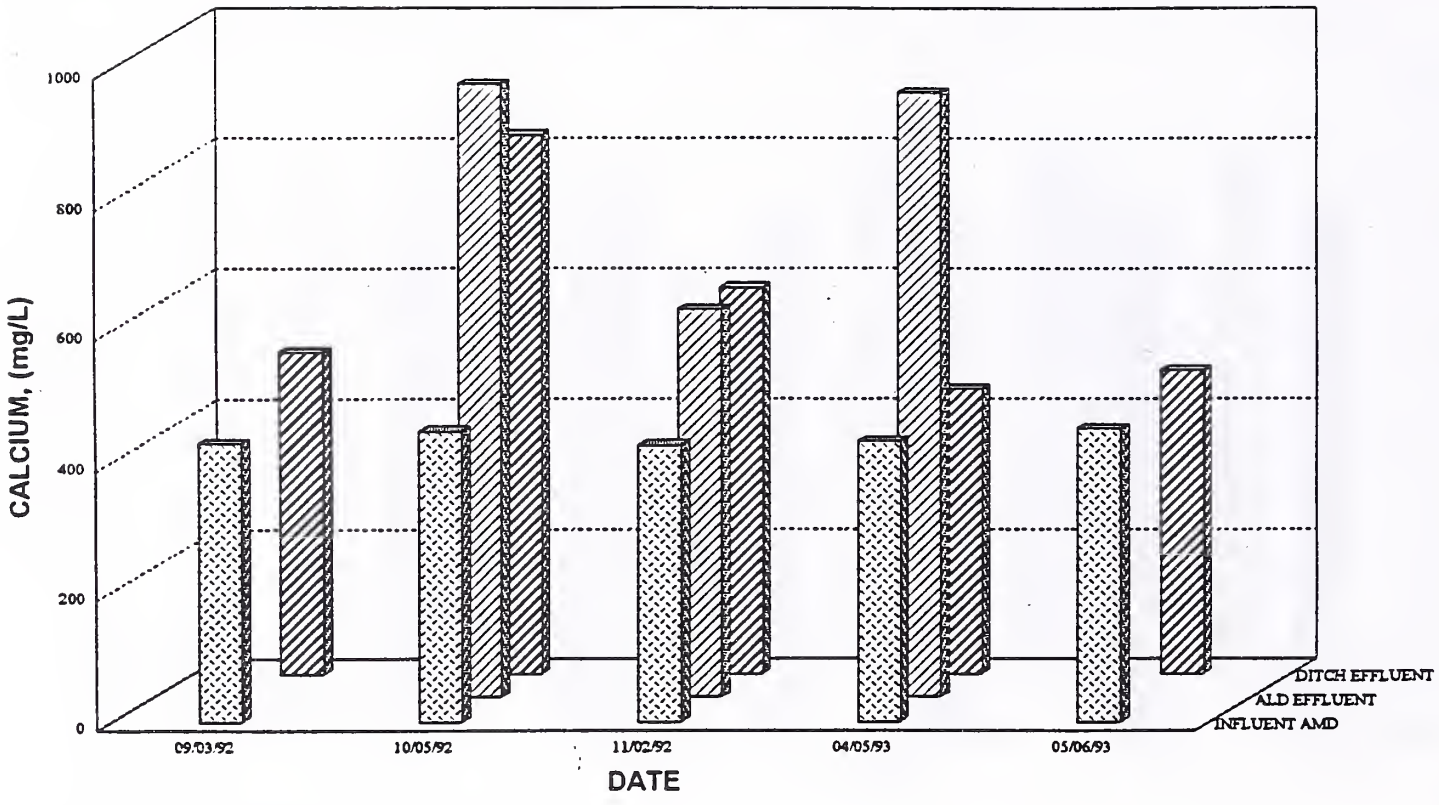

Figure C.14 Calcium analyses at the Stockett West Ditch since start-up.

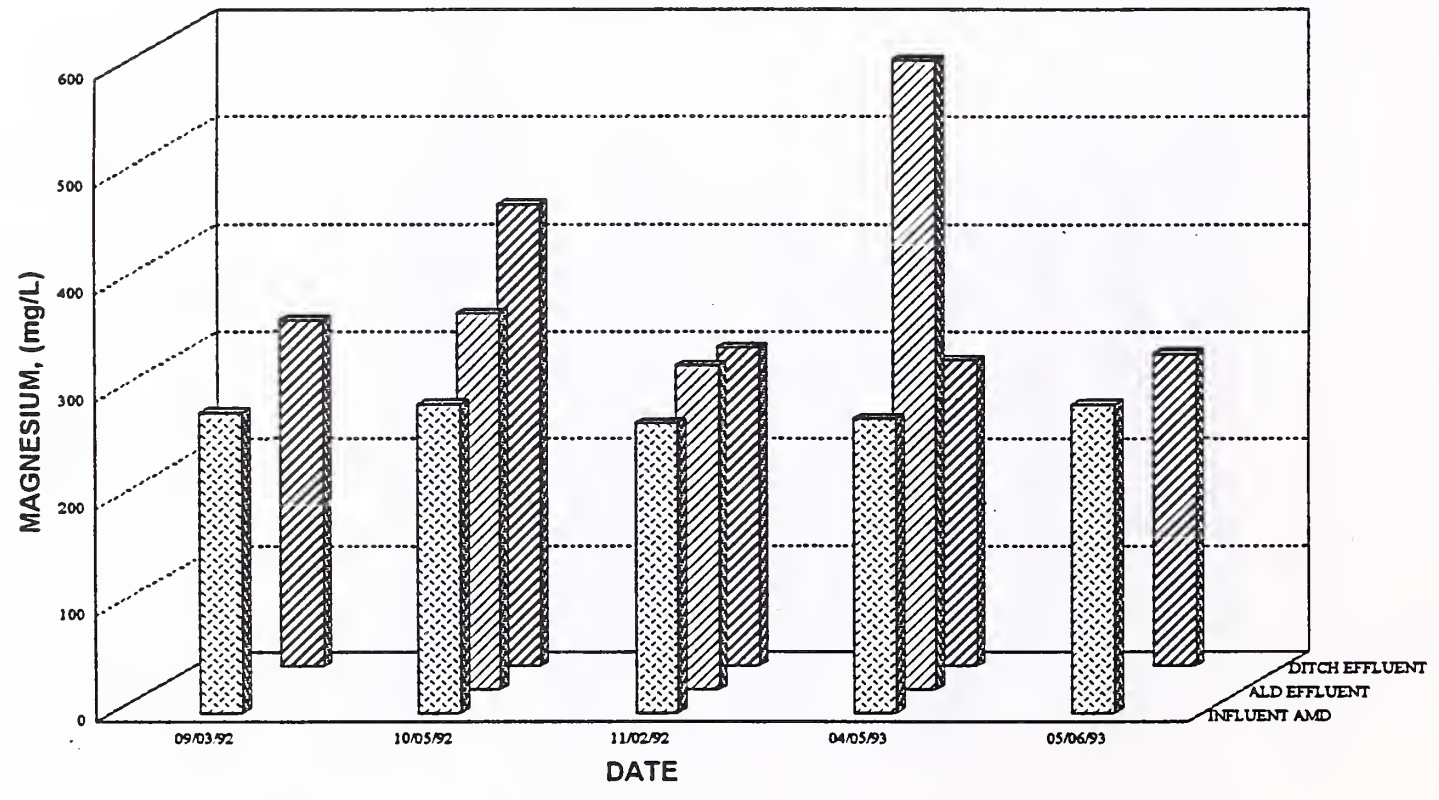

Figure C.15 Magnesium analyses at the Stockett West Ditch since start-up.

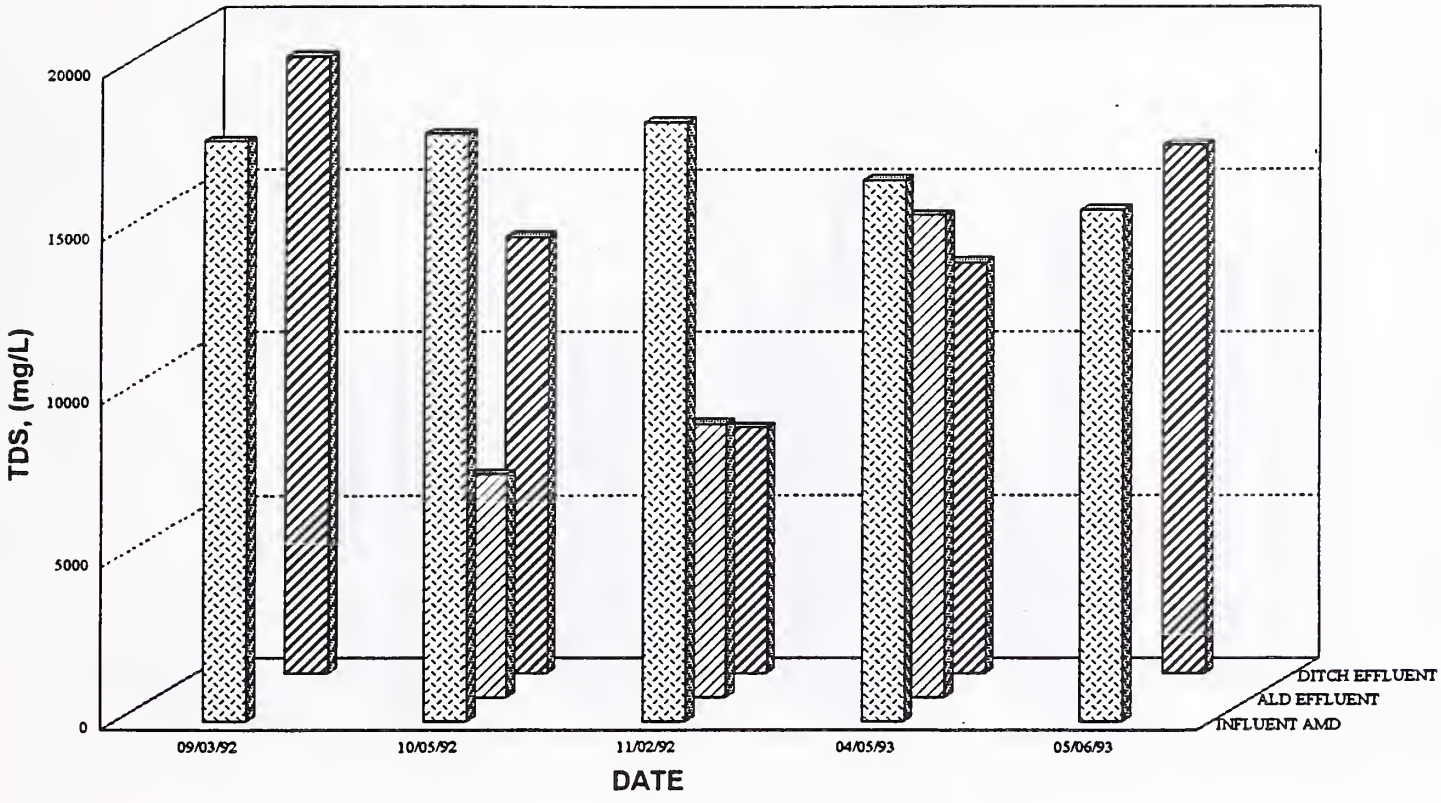

Figure C.16 TDS analyses at the Stockett West Ditch since start-up.

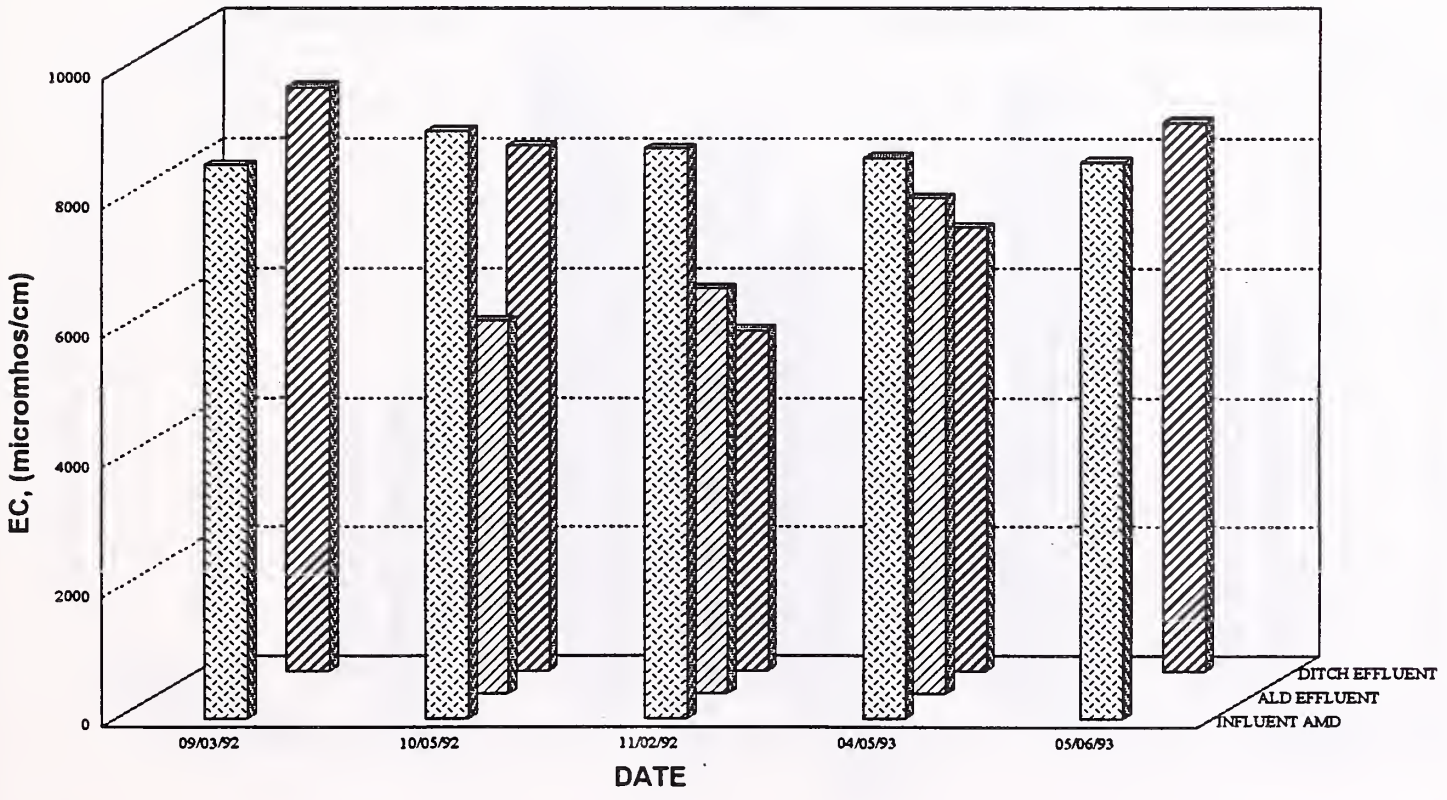

Figure C.17 EC of waters at the Stockett West Ditch since start-up.

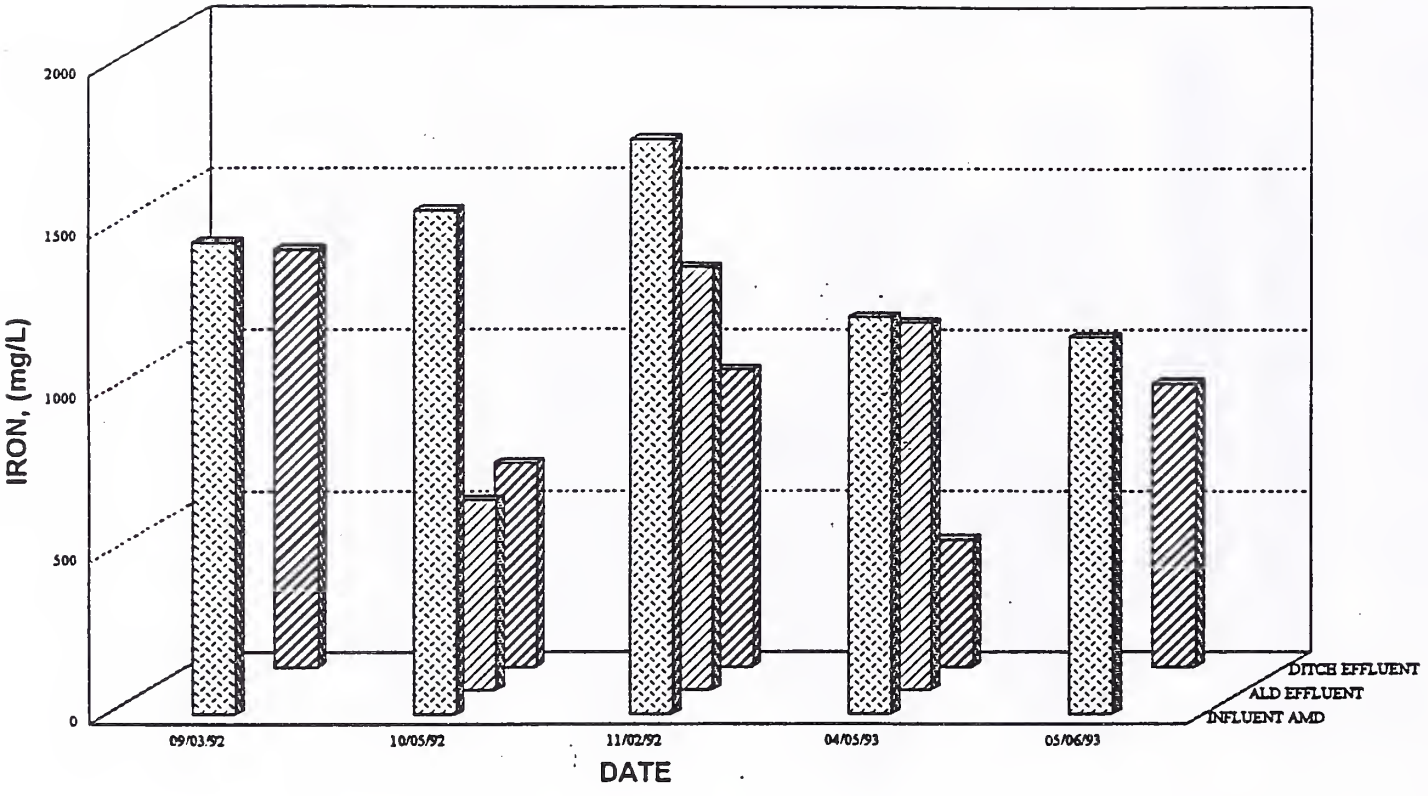

Figure C.18 Iron analyses at the Stockett West Ditch since start-up.

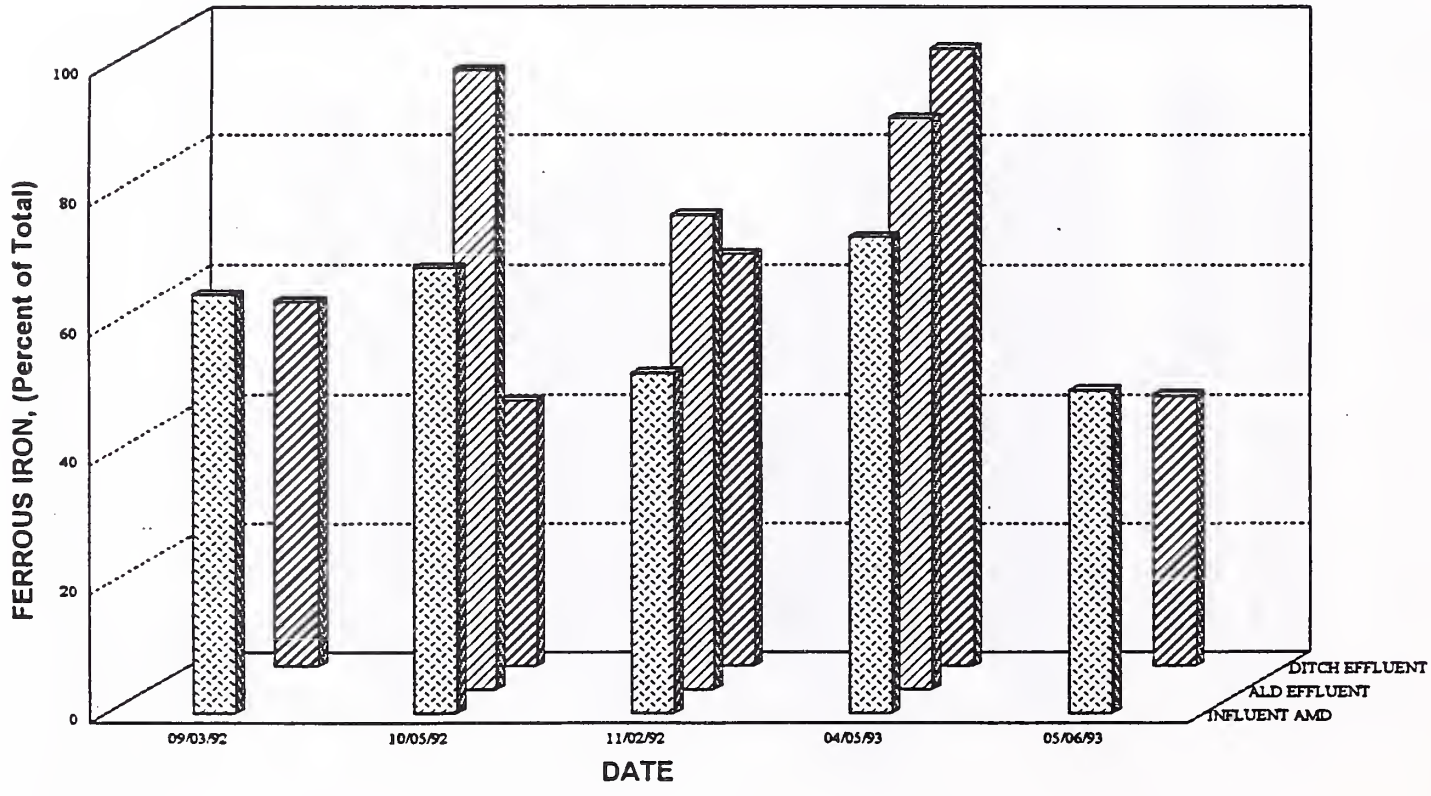

Figure C.19 Ferrous/Ferric ratios at the Stockett West Ditch since start-up.

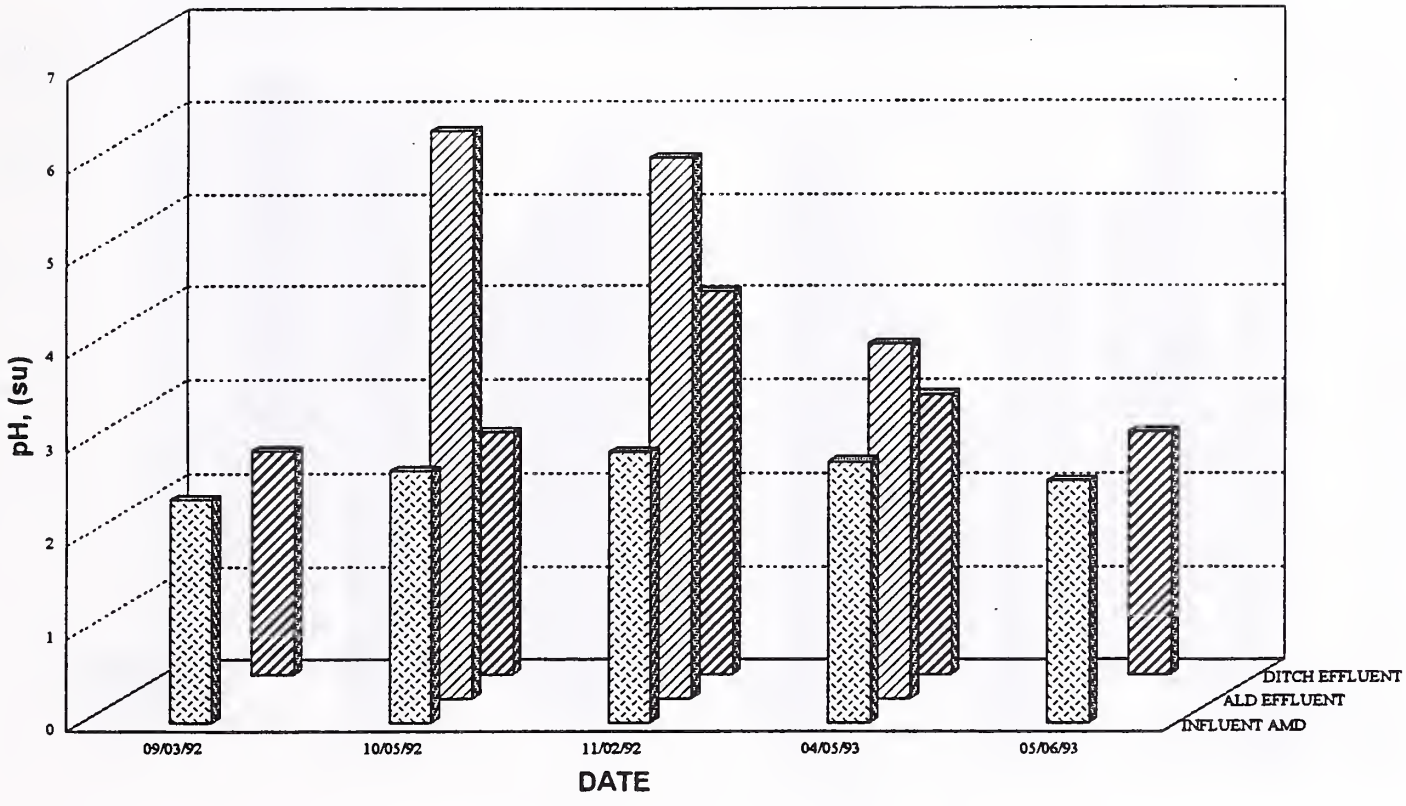

Figure C.20 pH measurements at the Stockett West Ditch since start-up.

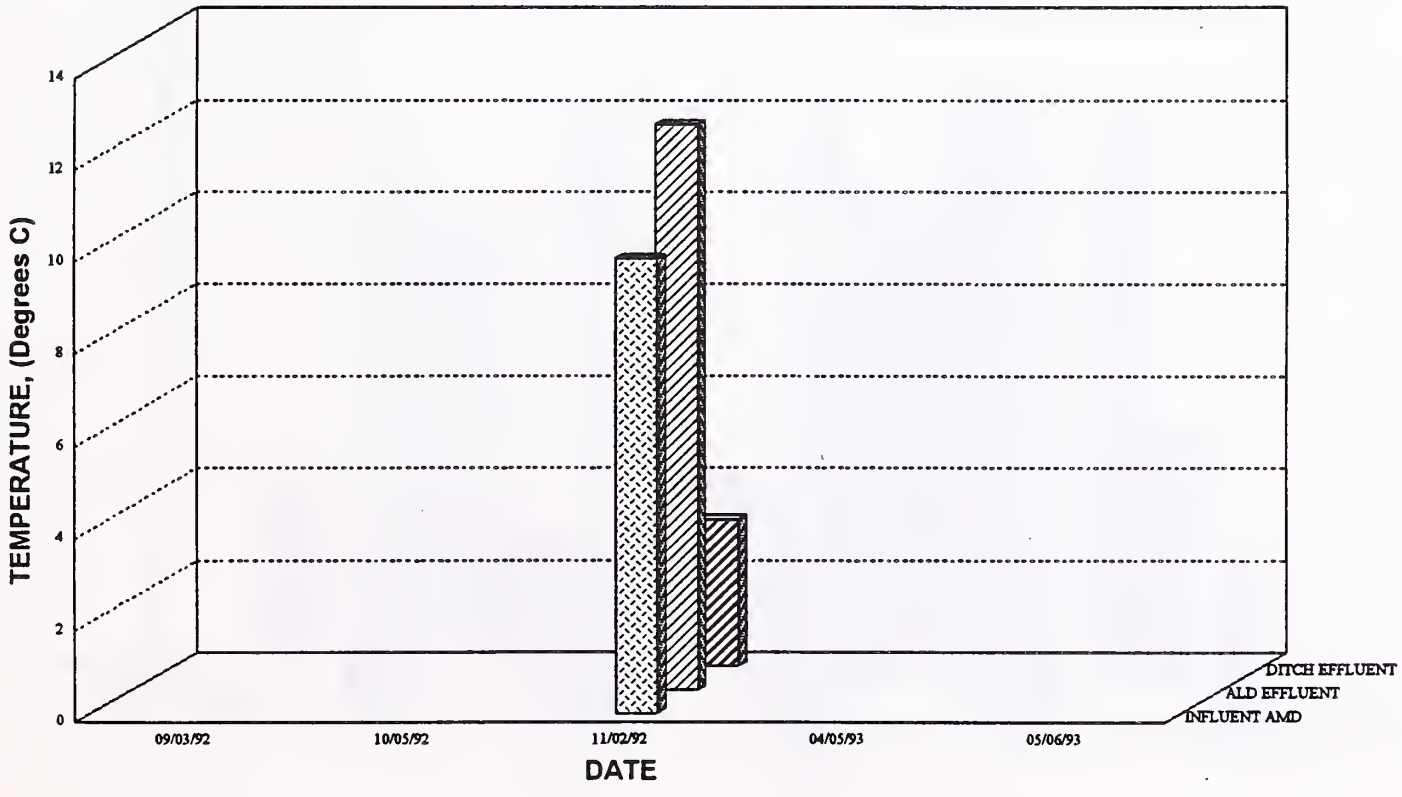

Figure C.21 Temperature measurements at the Stockett West Ditch since start-up.

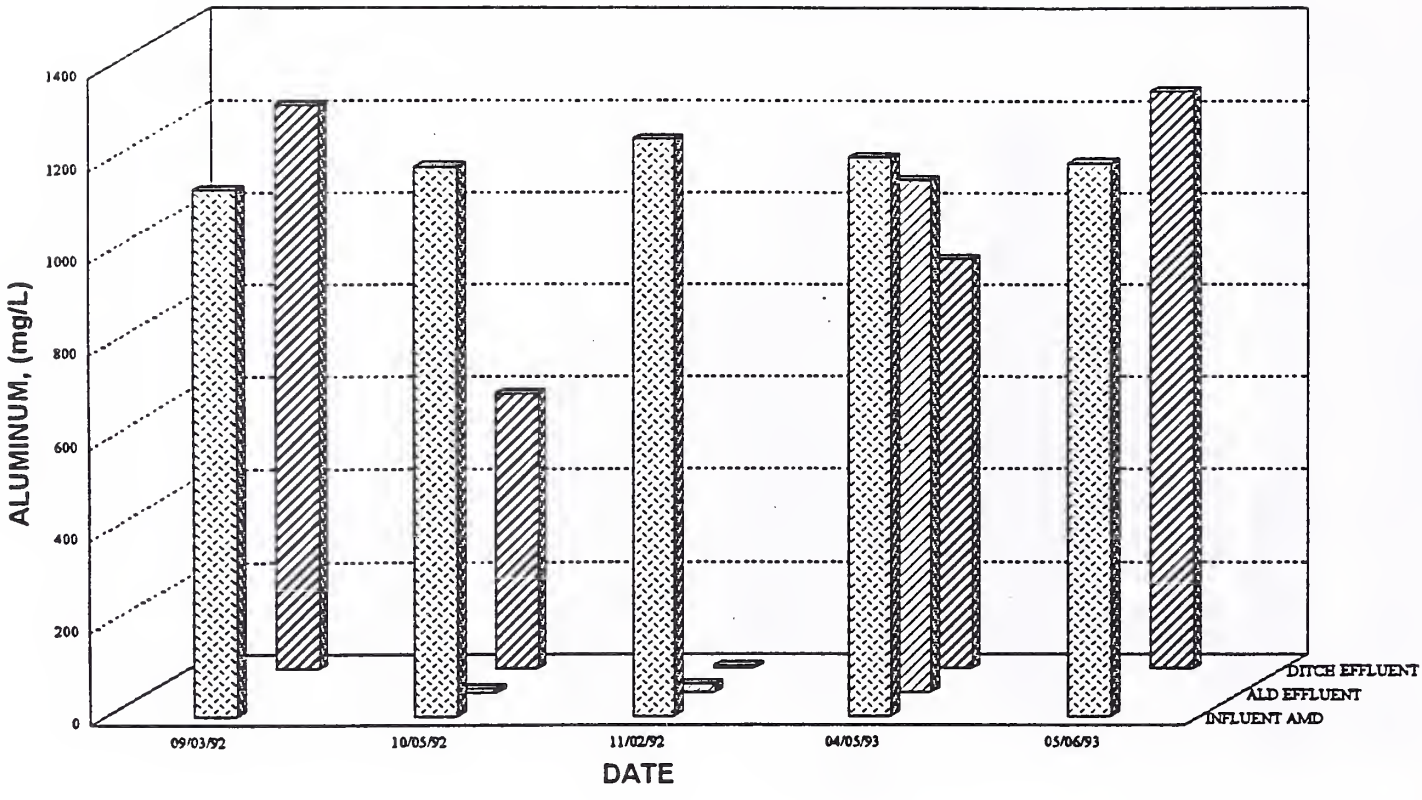

Figure C.22 Aluminum analyses at the Stockett West Ditch since start-up.

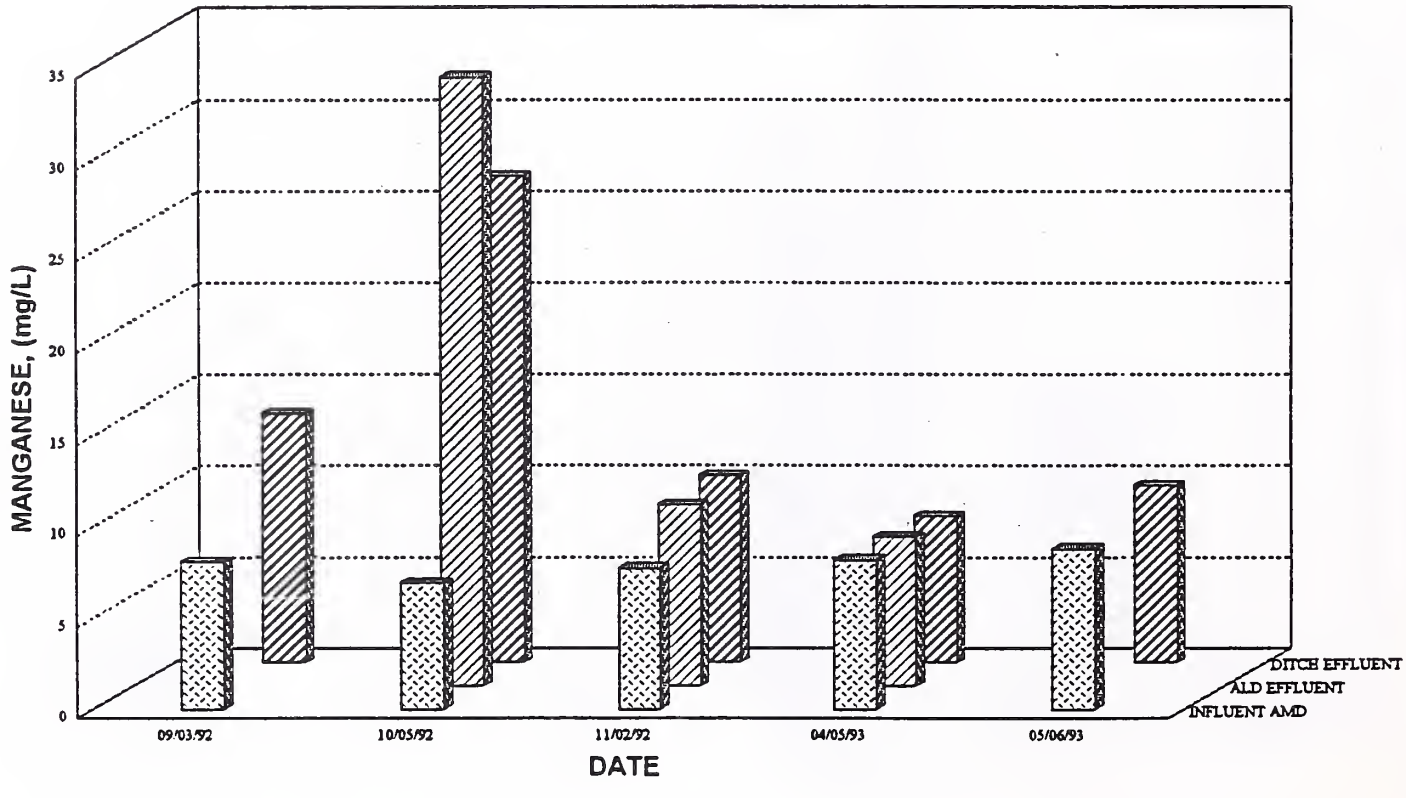

Figure C.23 Manganese analyses at the Stockett West Ditch since start-up.

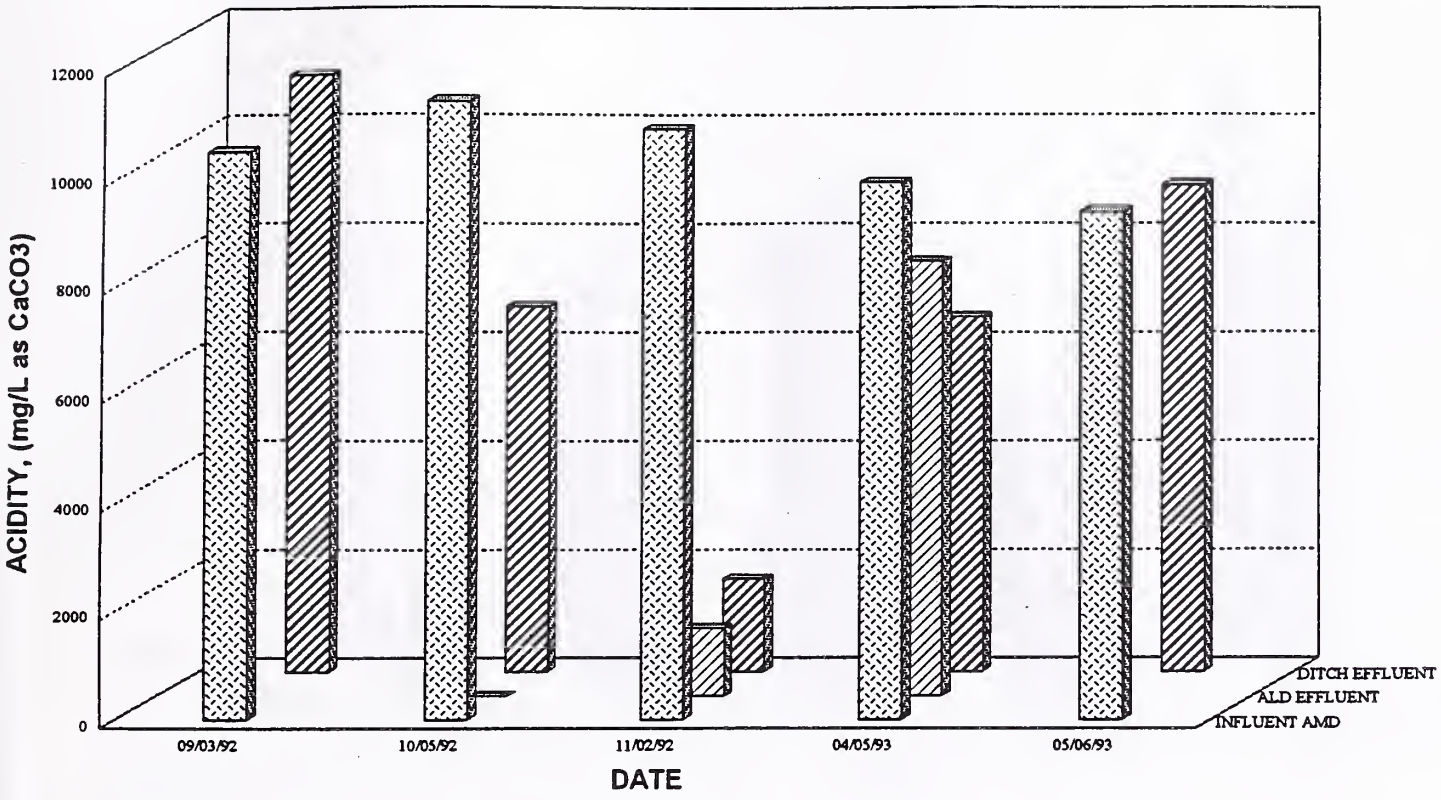

Figure C.24 Acidity analyses at the Stockett West Ditch since start-up.

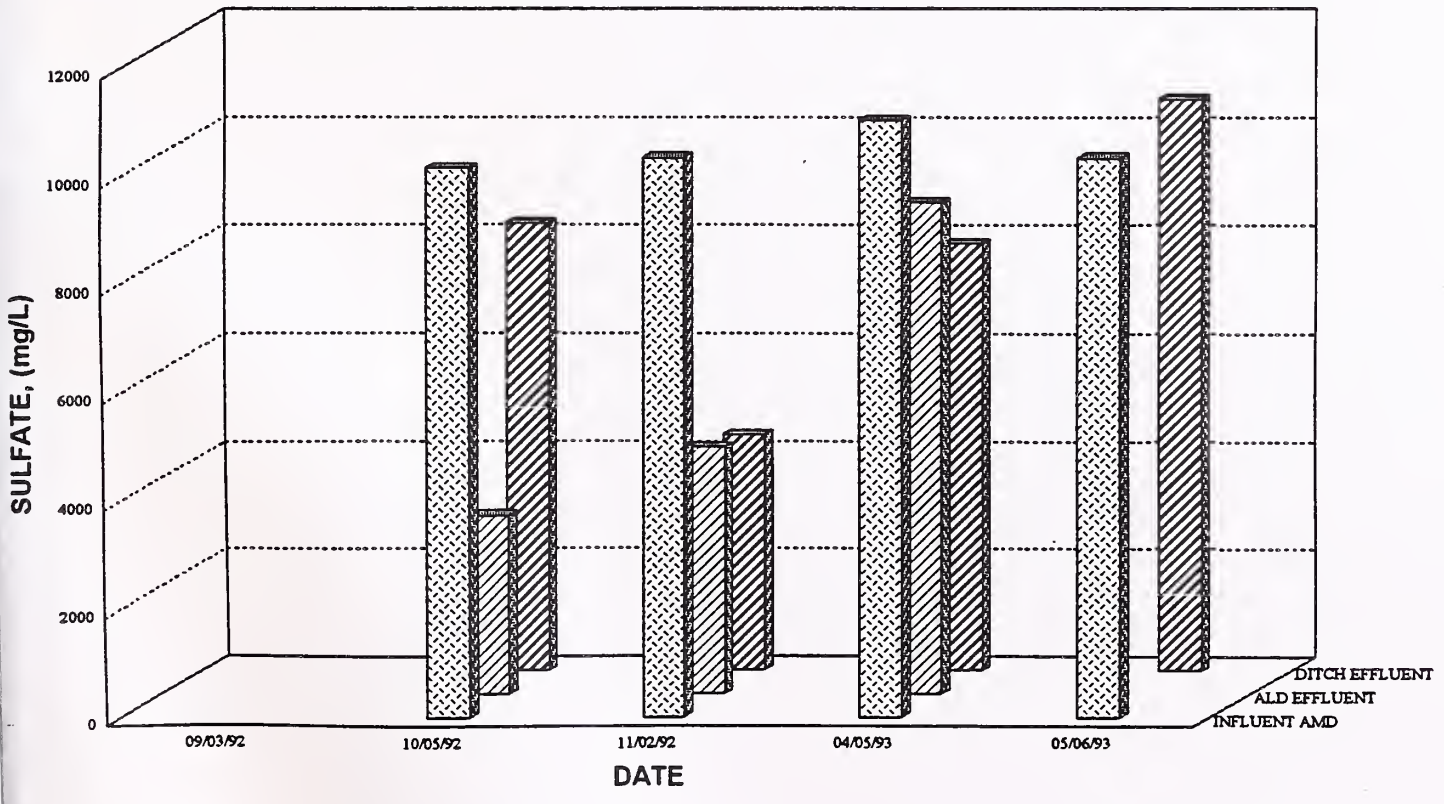

Figure C.25 Sulfate analyses at the Stockett West Ditch since start-up.

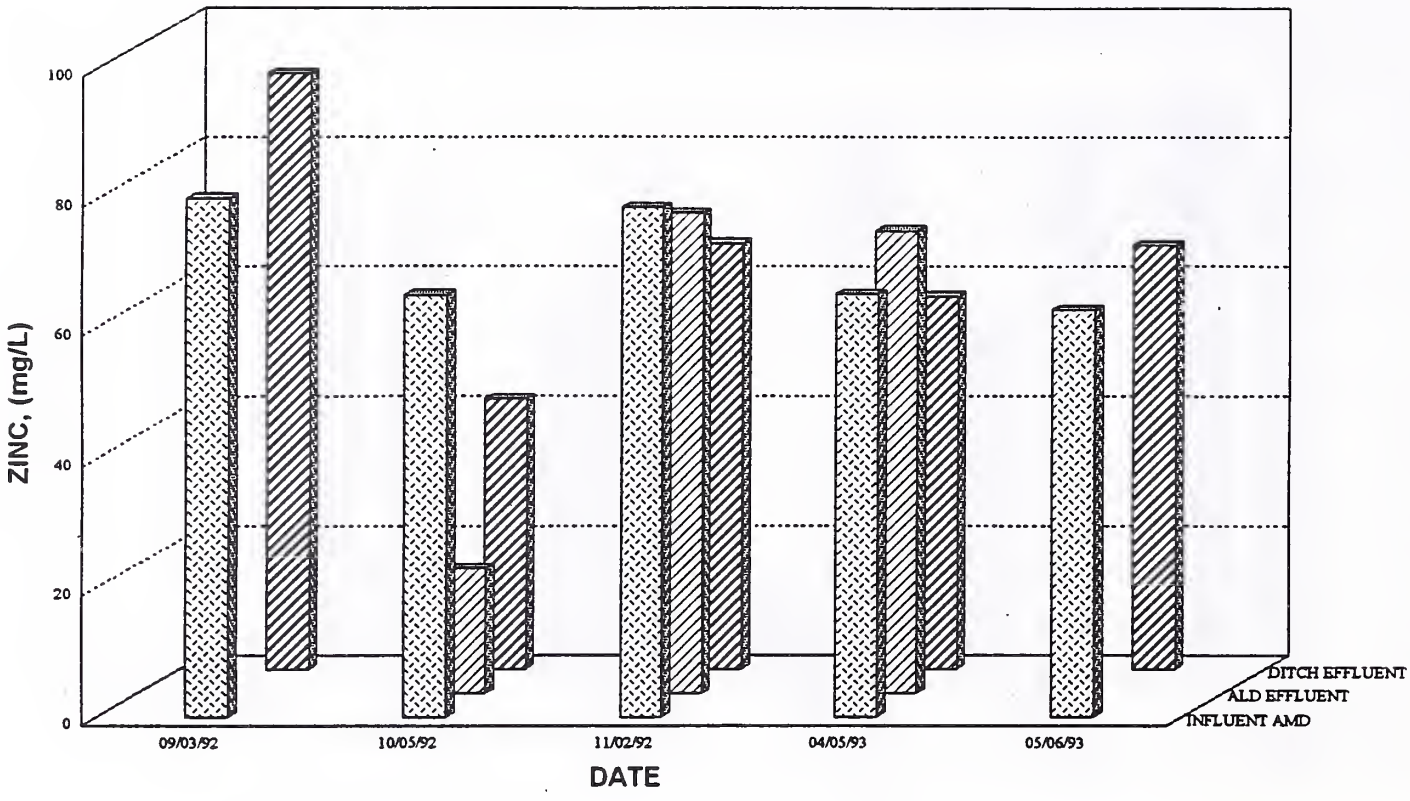

Figure C.26 Zinc analyses at the Stockett West Ditch since start-up.